MARCH, 1942

ELECTRICAL SOUTH

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THE Dinkler Hotel System continues to provide the latest equipment and comforts for its many guests. • HUNTER furnished the Dinklers with their first large shipment of electric fans 25 years ago. Since that time every improvement developed by HUNTER engineers has been installed in Dinkler Hotels. • A large order for HUNTER Zephair Coolers has recently been delivered to five hotels in the Dinkler chain. Dinkler and HUNTER engineers have worked out a method of fresh air circulation on many floors of these buildings which will prove to be the source of natural ventilation.

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fewer time outs

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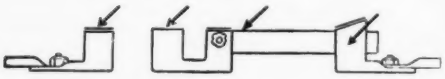

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Extra joints in current-carrying parts mean extra chances for loose connections and heat losses. That's why Westinghouse Safety Switches, with 2 to 7 FEWER joints per pole, save power . . . take less time out for maintenance and adjustments.

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Give important production circuits this added protection. Call your nearest Westinghouse Agent for prompt service! Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

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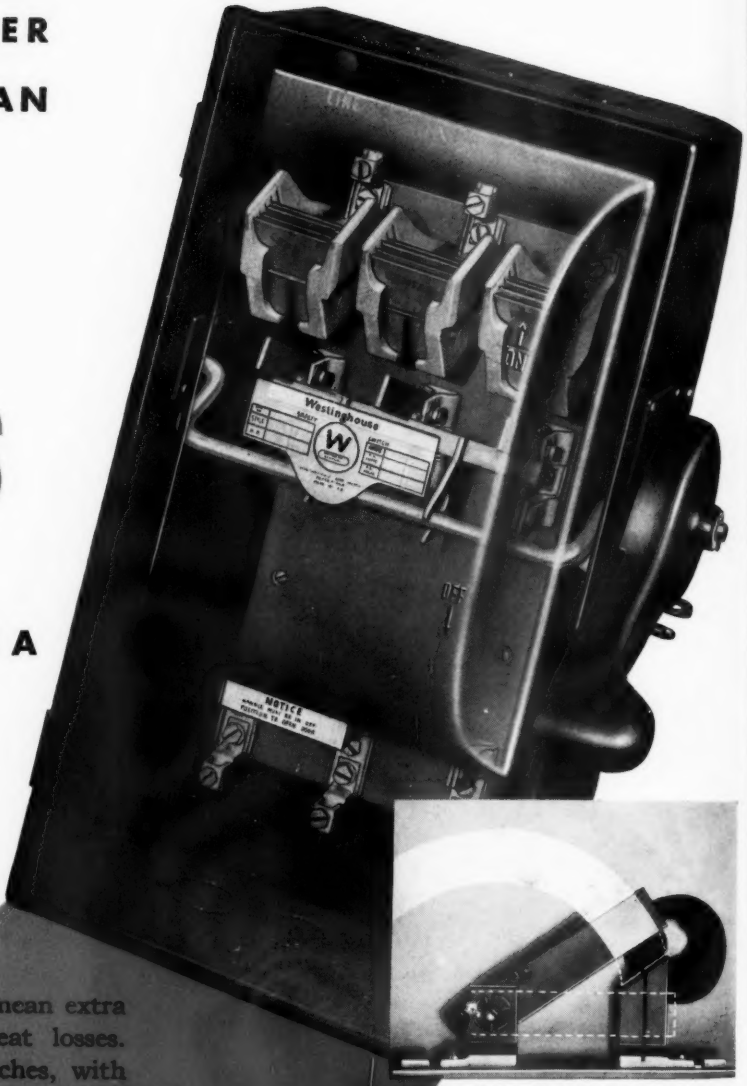
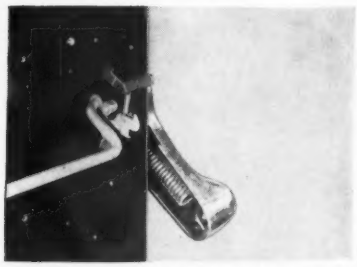


ARCING STAYS OUTSIDE CONTACT AREAS—Blade extends beyond break jaw, which is diamond pointed. Arcing thus occurs outside contact areas, assuring clean contacts at all times.



OPERATING MECHANISM OUTSIDE CABINET, away from wiring. This feature leaves more wiring space, prevents possibility of mechanism chafing against insulation or short circuiting.

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Ships for every ocean . . . ships for every need . . . battleships, cruisers, carriers, submarines; ships for troop transport and supply . . . ships will win this war.

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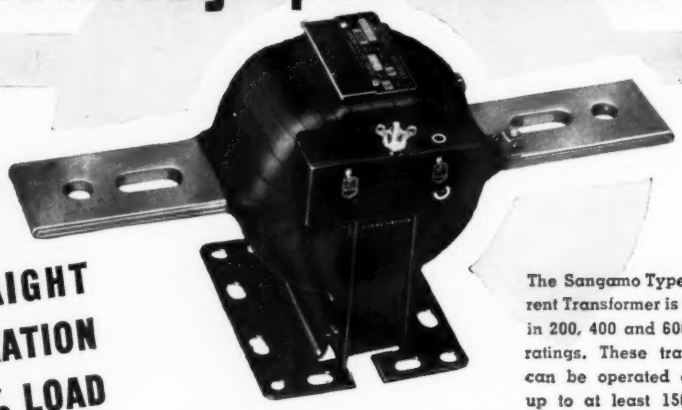

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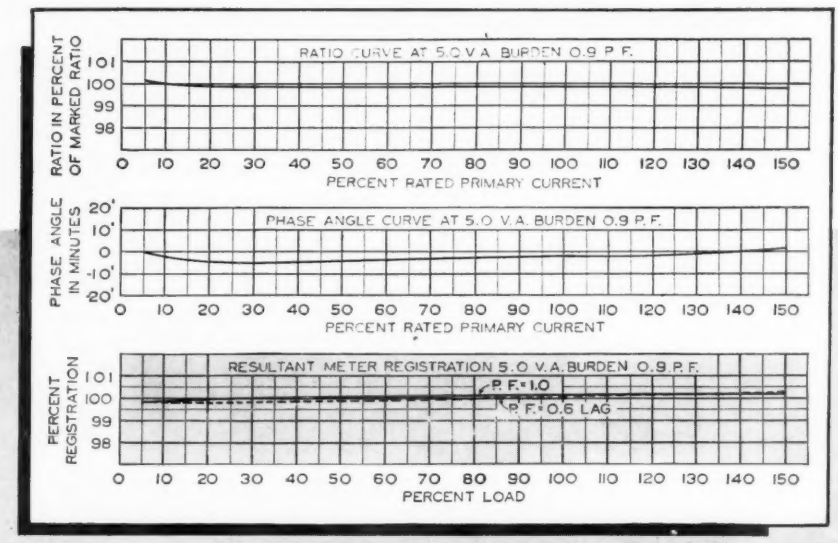
RATIO CURVE AT 5.0 V.A. BURDEN 0.9 P.F.
RATIO IN PERCENT OF MARKED RATIO
101
100
99
98
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
PERCENT RATED PRIMARY CURRENT
PHASE ANGLE CURVE AT 5.0 V.A. BURDEN 0.9 P.F.
PHASE ANGLE IN MINUTES
20'
10'
0
-10'
-20'
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
PERCENT RATED PRIMARY CURRENT
RESULTANT METER REGISTRATION 5.0 V.A. BURDEN 0.9 P.F.
P.F.=1.0
P.F.=0.6 LAG
PERCENT REGISTRATION
101
100
99
98
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
PERCENT LOAD

☆ The E. E. I. specified a metering current transformer, insulated for 600 volts in 200, 400, and 600 ampere ratings, capable of carrying 150% load without undue heating, and with electrical characteristics which, with a burden of 5 volt amperes at 90% power factor, would not affect the watthour meter accuracy at any power factor from unity to 60%, lagging more than plus or minus ½ of 1%. How the Sangamo Type M-6 Current Transformer meets and exceeds these specifications is shown in the watthour meter registration curve. Even though the variations are small, the ratio and phase angle curves have been so balanced in their individual trends, that they reflect a practically straight line meter registration from 5% to 150% load.

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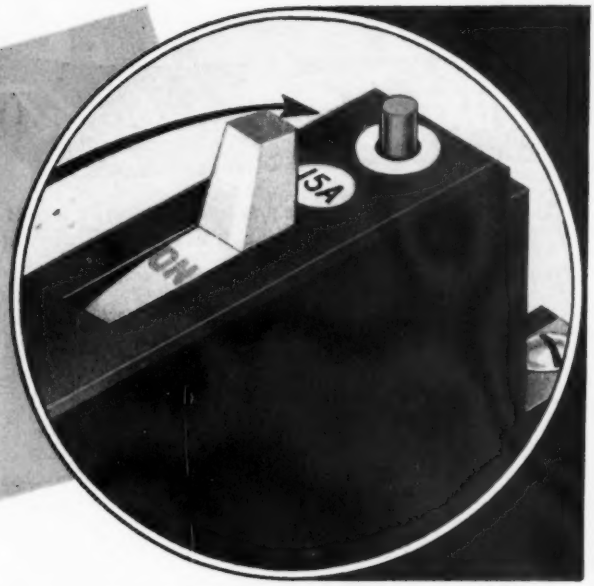
Volume 22 Number 3

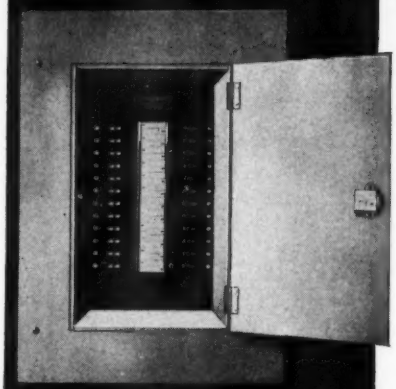
When tripped— red button protrudes



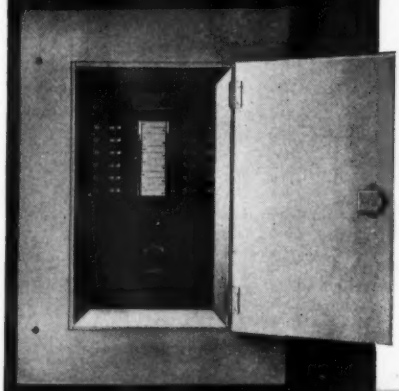
You can see at a glance which circuit has been affected. Even in the dark you can ascertain where the trouble lies — the projecting button tells the story . . . This is but one of the many features which have gained favor for

Dublbrak Circuit Breaker PANELBOARDS

Protection against harmful overloads is assured — and, due to proper time lag characteristics, annoying interruptions of service, from short circuit or momentary overloads, are prevented.



Ⓕ Dublbrak Circuit Breaker Panel board and Cabinet, with main lugs only. (Catalog No. NA1B24-3L100).



Ⓕ Dublbrak Circuit Breaker Panelboard and Cabinet, with main breaker. (Catalog No. NA1B12-3AB100).

★ There are only two positions of the handle — ON and OFF. *There is no intermediate position.*

★ Contacts are double-break, to provide low arcing . . . quick make and quick break for manual action, and quick break on automatic operation from sustained overload or short circuit.

★ Main bus bars are made of 98% pure hard-drawn copper, and direct copper-to-copper contact is made to circuit breakers.

★ The binding screws cannot be removed. Corrugations in the neutral connection plate prevent wires from turning when the screws are tightened.

★ Each Ⓕ Dublbrak Circuit Breaker is equipped with Ⓕ wire terminal connectors of the clamp contact type. The wire is inserted into a flared opening, and fastening screw tightened. *No washers or other parts are needed.*

★ Boxes are of code thickness steel, with knockouts to meet every requirement . . . 4-inch gutters make connecting easy.

★ Fronts are bonderized to prevent rusting, then finished in pearl gray lacquer. They are equipped with Ⓕ front fastening device, for ease in centering and plumbing.

★ Panelboards from 2 to 42 circuits are assembled from *standardized units.*

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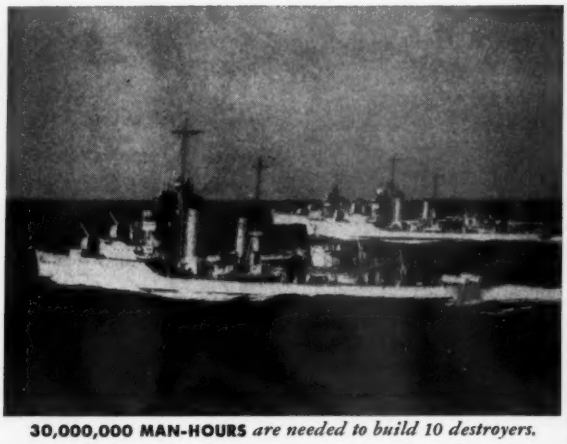
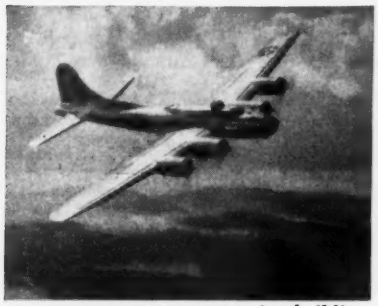
Better light has increased production as much as 5 to 15% in many factories . . . if it could increase production by only 3% in vital war industries, it would be the equivalent of adding 300,000,000 man-hours a year to speed victory!

54,000,000 MAN-HOURS *are required to build two battleships.*



30,000,000 MAN-HOURS *are needed to build 10 destroyers.*



31,250,000 MAN-HOURS *go into building 250 big bombers.*

12,500,000 MAN-HOURS *are used to build 500 fighter planes.*

28,000,000 MAN-HOURS . . . *500 big tanks, 1000 medium, and 1500 light tanks.*

EVERYONE in the lighting industry knows that good light . . . lots of light . . . increases production and decreases errors without adding to floor space, hiring new men, or installing new machines. Recent reports show that better lighting has increased production in factories from 5 to 15%.

It is estimated that 1,000,000 of the 6,000,000 workers in vital industries already have modern lighting. If better lighting increased the production of the remaining 5,000,000 by only 3%, it would be the equivalent of adding 150,000 men. Assuming 2000 hours per year, better light could provide 300,000,000 *extra* man-hours annually.

To produce the number of ships, planes, and tanks indicated above would require approximately half of these 300,000,000 man-hours . . . *leaving the other half to produce food, ammunition, and supplies.*

Even today, thousands of businesses don't have modern man-hour saving light. These businesses need to be convinced of the importance of this modern production tool. That's the job cut out for the whole lighting industry to help win the war.

• • •

To help you interpret the job that modern lighting can do in plants that need it most, General Electric has a booklet, "How Light Can Help" . . . telling this story in greater detail. A copy is yours for the asking. Write General Electric Company, Dept. 166-ES-C, Nela Park, Cleveland, Ohio.

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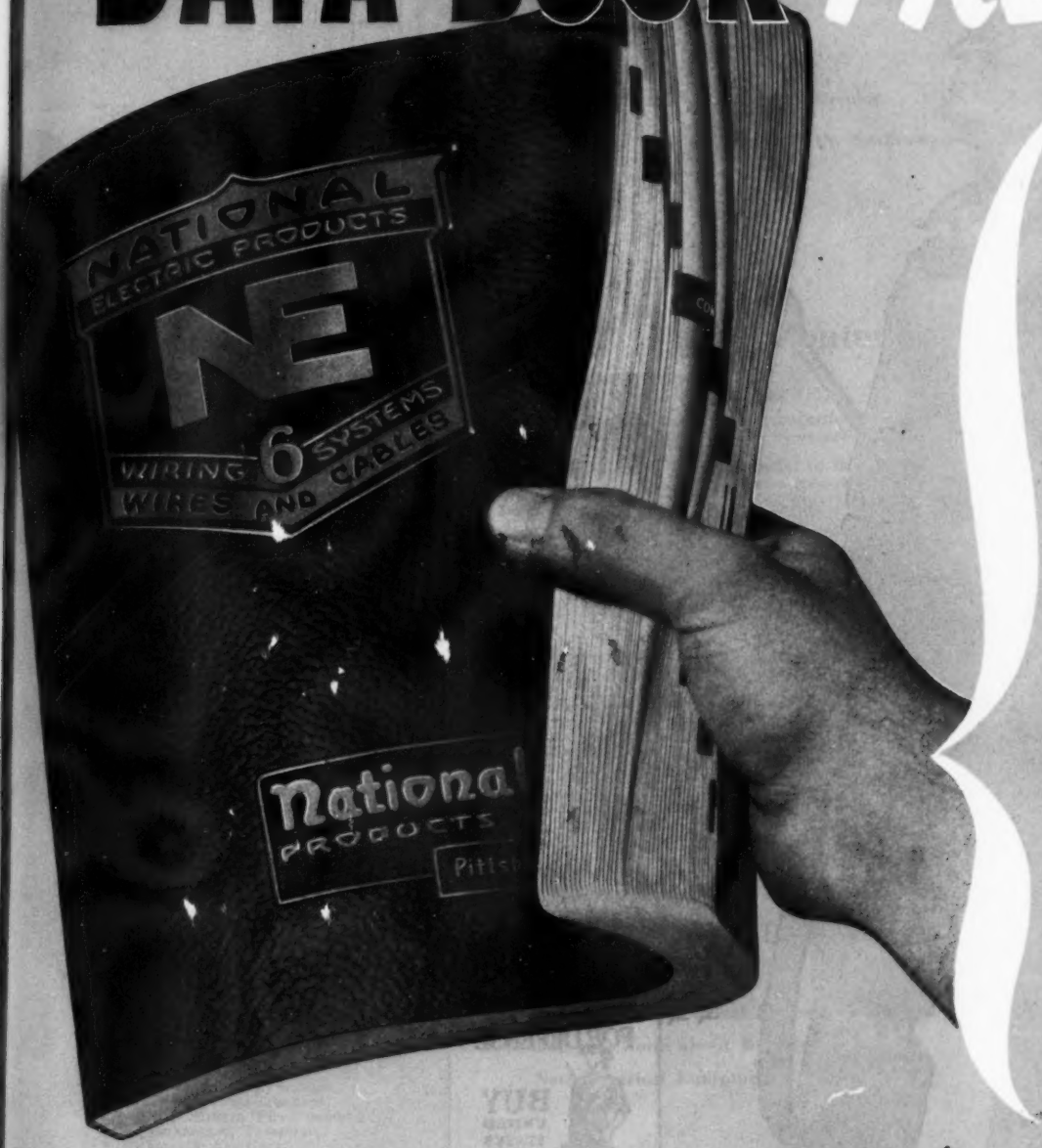

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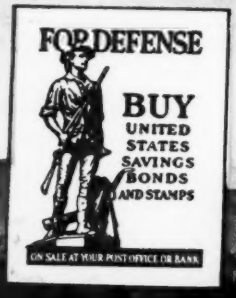

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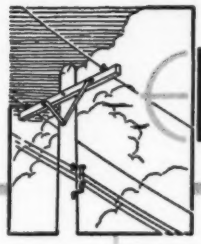

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This tail wags the "dog"

An achievement of Anaconda research aiding both our war effort and our industry.

MINES . . . one of the necessities of our gigantic war effort . . . today rumble with the noise of *work.* To keep this rumbling rhythm steady and incessant, mining machines and transportation systems use large quantities of electrical power.

Here, a bustling locomotive carries its electrical power around with it . . . like a tail. Over sharp-edged rails, thumping over shaggy, splintered ties, reeling and unreeling as the locomotive moves back and forth, the "tail" . . . the copper power cable . . . stands up day after day delivering the ever-so-vital power without interruption.

Sunex Securityflex*, a product of Anaconda research developed to withstand not only the rough and tumble conditions of underground mining but also the sun blistering service of open pits, is the "tail" that's wagging many mining dogs. And the research that built it, the invaluable hours of patient experimenting and testing, now speeds to develop copper wires and cables for an even more potent war effort . . . for a greater industrial front . . . for use in mines, in war-vital plants, in bombers and battleships. 42243

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ELECTRICAL SOUTH
MARCH, 1942

INDUSTRIAL MODERNIZATION— Opportunity for Electrical Industry

FOR SEVERAL MONTHS the electrical industry has been conscious of the change that faces it in the years immediately ahead, but only now is the new pattern becoming apparent.

One of the bright spots in this confusing situation is to be found in the possibility of developing extensive electrical modernization in the South's industrial plants. A large percentage of these plants are engaged in the manufacture of products needed directly for the Victory Program or for essential civilian requirements. Surveys made in the past indicate that nearly all industrial plants have insufficient lighting, and the twenty-four hour operating schedules are making this an even more important consideration than it has been in the past. Just as great is the need, in many plants, for adequate wiring, for more efficient motor control, and effective circuit protective equipment.

Obviously, only the industrial plants most essential to the Victory Program can obtain the necessary preferential rating for extensive electrical modernization, but these plants alone represent a tremendous electrical construction market. The growth of industry in the South has been so constant in the past two or three decades that it has been taken for granted by many who have not realized its significance. A glance at a few of the principal industries of the South offers encouraging evidence that the industrialization now under way throughout the South and Southwest, transforming vast natural resources into manufactured products, is one of the most important economic developments of this century:

—The pulp and paper industry of the South has attracted $225,000,000 in new construction in the past four years, doubling production capacity in the South.

—Over 60 per cent of the nation's construction of chemical plants in the past five years has been in the South so that the total in this area now amounts to 1700 plants having an annual output of $900,000,000 in chemical products.

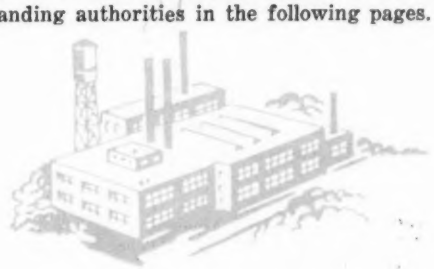
—The South now produces nearly half of the nation's mineral products, having shown a gain of 500 per cent since 1910 as against 60 per cent for the rest of the country.

—In textiles, the South has taken the lead with annual production exceeding $1,000,000,000 and representing 84 per cent of national cotton manufacture. Similarly, the South now produces 75 per cent of the nation's rayon and 50 per cent of rayon fabrics.

—Production of gas, oil, and other refinery products in the South now exceeds $1,000,000,000 annually making petroleum one of its major industries.

Thousands of these industrial plants are badly in need of modern electrical equipment and represent a profitable market for the electrical industry. And this modernization program not only benefits the electrical industry, but increases the efficiency of the plants, thus aiding the Victory Program.

Because of this focussing of interest on the industrial field, ELECTRICAL SOUTH presents a comprehensive review of "Industrial Electrical Modernization" in this issue. Particular emphasis has been placed on wiring, lighting and the phases of industrial electrification that are most essential to efficient, dependable operation. As motors and other electrical equipment become more difficult to obtain, the need for modern circuit protective equipment is greatly increased. Power factor improvement apparatus may be the answer in many plants to overloaded circuits, excessive voltage drop, and need for additional transformer capacity. These and many other related topics are discussed by outstanding authorities in the following pages.



INDUSTRIAL MODERNIZATION

Modernization of electrical facilities in many industrial plants will result in greatly increased production, improved quality, more efficient utilization of man-hours.

By C. N. Rackliffe*

MANY INDUSTRIAL plans and aspirations have had to be pigeonholed for the duration. Regardless of the size or nature of our business, the present world situation is right in our yard, actually at our front door. There is not a single industrial plant in the United States that is not seriously affected, either directly or indirectly by the war. We have all had to make drastic changes in our entire outlook. Undoubtedly, as the months pass, additional changes and sacrifices will have to be made. In fact, the only thing of which we can be sure is that we are living in a rapidly changing world. Our industrial establishment will survive in proportion to our use of American ingenuity to devise new approaches to new problems.

The one big job before us is to win the war. The next big job, and equal in importance, is to win the peace that will follow. Unless we win that final victory, the first victory will be just the first act of a tragic drama of declining civilization. We *will* win this war, however, and we *will win* the *peace* that will follow and *Southern Industry will play a big part.*

When we think of electrical modernization for industries today, in the face of priorities, shortages, and production schedules, we are apt to throw up our hands and say "Impossible." To this you will quickly add a dozen very sensible reasons why it is impossible. These would include lack of time, high present cost of equipment, the uncertainty of the future, and on and on you could go with facts that seem very true. Why then should there be any time given to plans for modernization?

There is one sensible answer to the modernization question that can not be disputed. Our President has said that the successful prosecution of the war will depend on the important three M's—Men, Money, and Material. The South has sent, and will continue to send, its men, and lend its dollars, and pay its taxes. The industrial plants in our great Southland can best answer the "Material" phase of the three M's by the most efficient utilization of every square foot in our plants and the utmost modernization of our equipment. If there is anything that we can do to turn out a better product for the Victory Program, or produce the same product faster, or with less manhours, then we will have made a distinct contribution to our great nation in its drive for volume.

There is a story told that the Chinese decided they needed a word for crisis in their language. By this time we are almost callous to this word. The Chinese, counterbalanced by thousands of years of living, had not seemed to need a word for crisis. Today, however, it seems that our Chinese friends finally decided that they did need such a word. So they called together their learned men. After long consultation they found word pictures which, when put together, represented a word for crisis. The word pictures selected are very challenging to us today in the light of our industrial crisis. The learned men selected the word picture "danger" and the word picture "opportunity." Surely in every crisis there are dangers, but likewise there are great opportunities.

The industrialists of the South are not afraid of dangers and have aways capitalized on their opportunities. Today we have the biggest opportunity that we have ever had to prove that the South is more than the nation's "Number 1 Economic Problem." The new tomorrow will find Southern Industry seeking every opportunity to produce more and more for the Victory Program. An ever-increasing volume of war material will pour from our plants. Present peace time industries will convert themselves to war production as we substitute the word "opportunity" for the word "impossible" in our vocabulary.

For the purpose of our electrical modernization discussion, it will be well to divide industries into two general classes. One class consists of those now producing, or able to produce, defense materials. The second class consists of industries unable to adapt their plants to the defense production. Our discussion will follow this pattern.

Several months ago a Southern yarn mill desired to purchase some additional equipment involving some spinning frames and individual drive electric motors. They were blocked. Priorities had to be secured or no material could be obtained. The president of the mill traced the yarn that was being manufactured and to his surprise found that more than 80% was going directly into defense materials. With this ammunition in hand, he was able to get the priorities necessary to obtain the modernization equipment with the most modern electric drives. Today, this mill has stepped up its yarn production, doing a better job faster because it is doing it in the most modern way. As a result, our nation is the gainer.

Better Lighting Urgent Need

This mill did not stop with just new equipment to spin yarn. The management had long realized that they were operating under starvation levels of illumination. Oh yes, they had some light from the windows, at least for some hours of the morning and through the early afternoon. But, the dark days of winter came and the mill desired to run on two shifts and then three shifts. It was quickly realized that a person can work only as fast as he can see, so the modernization program was extended very properly to the lighting system. Today the plant can be "blacked out" with

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*Mr. Rackliffe is assistant to vice president, Carolina Power and Light Co., Raleigh, N. C., and chairman of the Industrial Power Sales Committee, Southeastern Electric Exchange.

black paint on the windows, if necessary, but on and on production can continue with each shift operating at peak efficiency. This modernization proved to be economically sound to the mill as well as an aid to the nation's production.

Another example of the value of modernization is illustrated by a well known metal working plant which is devoting its entire effort to defense production. The product being manufactured is so very modern that its use is still experimental. This plant was given a governmental order several weeks ago that would have staggered the wildest dreams of the industry several years ago. In past months such orders could be completed with proper regard to convenience and individual desire. Since December 7th the story is different. We have adopted slogans such as "Remember Pearl Harbor" and "Time Is Short." We are now fighting for our very lives and our American way of living. Such things make a difference.

How can the job be done today in this plant? There is only one answer, lengthen the hours of operation so that the plant can be operated on two shifts, or even three shifts if necessary. The economic advantages of the two or three shifts are evident even on the surface. It would be ridiculous to expand the plant, requiring more space, new equipment with its corresponding cash outlays, and increased electrical demands. Such a move would take months and a large capital expenditure, if it could be done at all.

A complete survey of the plant was made. It was found that this important industry could not add another shift. The plant, with all its vital equipment would have to shut down with the shades of night. The sad story was that even though the plant produced a 1943 product, the lighting was essentially the same system that was originally installed years ago when the plant was first built. This particular plant had a total connected load in lighting of approximately 18 kilowatts. In order to achieve even a minimum standard of illumination this should be stepped up to 190 kilowatts.

Here modernization is a patriotic duty, as well as an economic necessity.

Obtaining the Equipment

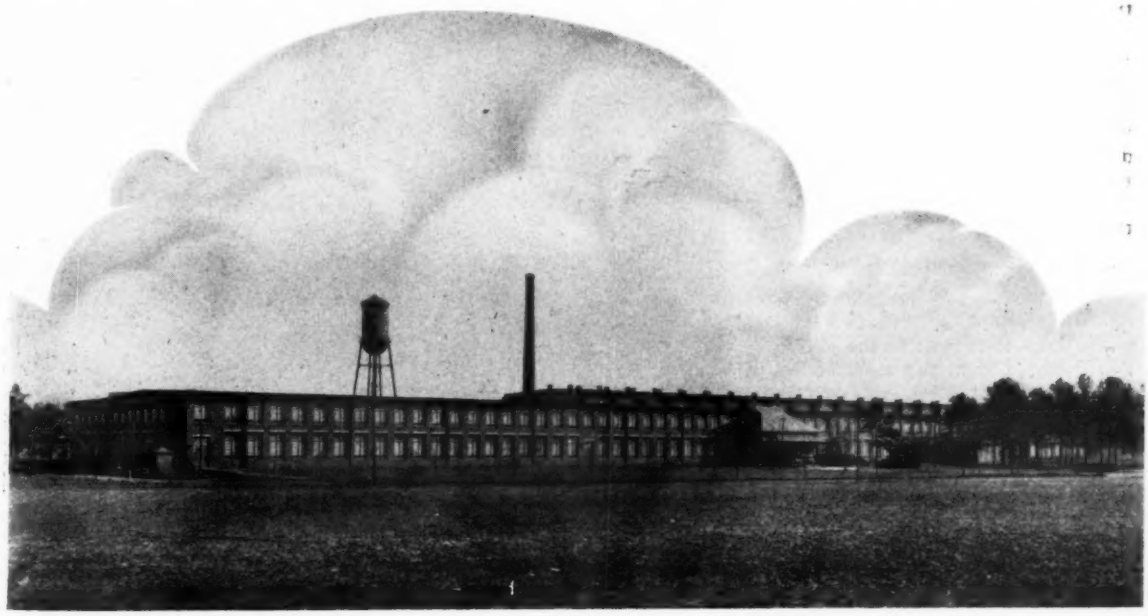
Can the equipment be obtained? It should be possible to obtain such modernization equipment in defense production plants. There should be no question of cost if the addition of lighting equipment will make possible another shift which will double the production of those things so vitally needed today. Here a dollar of modernization will work the good of hundreds of dollars worth of material in expansion.

These simple illustrations prove the point that modernization is an aid to production. As such, it is a vital necessity today in defense manufacturing. We are all in agreement that every plant should produce to the point of highest efficiency. If there is a better way that we can do a job, then it is more important today than ever to seek out this better method and install it as quickly as possible. By following this policy we will produce the most possible in the least time and at the lowest cost, with the maximum conservation of capital. If modernization will do this, then we should take our heads out of the sands of trouble, and get a broader vision of the part we can each play in the drive for more production. Ask yourself the question, "Could I do a better job for my nation if my plant were more modern?" If the answer is yes, then plan the first step today.

There are many industries that have no defense orders at the present time that might, through some shift of equipment or through the purchase of a few items of modern equipment, be in position to subcontract or take primary defense orders. This procedure will be the salvation of some of our Southern industries. Every effort should be made by these industries to research the field and pick up such business as is practical. Otherwise the economic status and organization of many of these industries may be adversely affected to a serious extent.

Naturally there are many industries throughout the South that do not produce items that directly contribute to the Victory Program and

(Continued on page 74)



Modernized Wiring Essential To Industry's Power Demands

By John M. Turnbull*

MODERNIZING of industrial wiring has become a desperately urgent project as America goes all-out for production. We must strengthen our electrical systems to meet today's demand for tremendous output. The immediate job in our old plants is to provide power of unlimited amount, planned to meet the 1942 and succeeding loads of industry which had a power growth last year of 28 per cent over 1940. More than one-half of the 140 billions of kilowatt-hours sold during 1940 went to industry.

The methods to be used to distribute these vast quantities of electrical energy will be important to electrical men (1) because sustained loads will have to be carried on 7-day-a-week schedules demanding the constant availability of power, and (2) because of the difficulty of obtaining materials coupled with the shortage of competent labor.

To meet these demands, we must, above all other considerations, build reliably. We must make our system flexible. We should achieve simplicity by avoidance of intricate protective schemes. We can expect standardization and simplification to be the outcome.

The wiring picture has changed. We have been running conduits (often buried) to preselected outlet locations. Today we need surface wiring to give ready access to conductors to obtain power supply for machinery which is subject to change from week to week or sometimes portable.

Each Plant an Individual Problem

Each wiring job needs individual study starting with two considerations, the load and the source of supply. The wiring must be designed to fit into both ends of this power picture. Proper engineering is still worthwhile even during these rush days, if we are to avoid an expensive maze of inflexible feeders. So, before modernization of wiring can be started, a survey must first be conducted to find out about such conditions as overmotoring, voltage drop, power factor, load balance and poor insulation. For example, an old plant was blowing a primary fuse on a transformer bank. The secondary was 115-volts, 3-phase, of which one leg was carrying 184 amperes, the other two only 80 and 124 amperes. The use of a clip-on ammeter revealed the difficulty.

The matter of rates and metering enter the study, though this commercial aspect should always be subordiate to service reliability, should these considerations conflict. As an example of how rates can govern the wiring method selected, one machine shop had in mind the use of busway to supply all load until they realized that the heating load, about one-half the total, could be bought at 2 cents per kilowatt-hour against an overall cost of about 3 cents for power and heat. The busway idea was discarded for separate conduit systems.

Designing the Service

The first step is to obtain from the power company the capacity required in switchgear to safely interrupt short circuit currents. Too often the growth of capacity on a supply system is not matched in the switchgear of industrial plants. In a recent case, a manufacturing plant was shut down because on a transformer bank short circuit the oil cricuit breaker ruptured on clearing the fault.

Regarding industrial distribution, there are basically two schemes. The newer thought is to carry high voltage to the load centers, there transforming to supply short low-voltage feeders. This is in camparison to the older radial system of transforming to low-voltage at the edge of the factory and from there extending longer secondary feeders to the loads.

The modern load center system

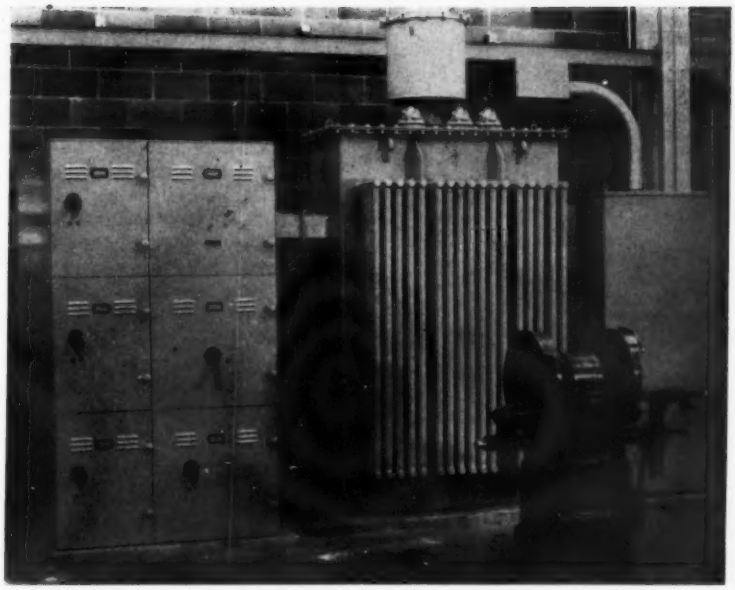
Maximum flexibility is one of the outstanding advantages of busway for industrial wiring. Here machines below are connected to the busway by means of rigid conduit and a circuit protective plug that can be supplied with fuse or circuit breaker. (Bulldog Elec. Prod. Co. photo.)

*Mr. Turnbull is service engineer, Western Massachusetts Companies, Springfield, Mass.

using more and smaller factory-assembled units has lower first cost for equal transformer capacity, saving through the use of lower capacity switchgear and of smaller primary cables. It allows for gradual growth. Its shorter feeders reduce voltage drop. It foregoes the benefit of diversity of load on transformer capacity unless secondaries are networked. One manufacturer advises that the plant network should be considered where two or more primary feeders are available, if the total peak is about 1000 to 1200 kva, or above, and the load density runs around 10 to 15 volt-amperes demand per square foot of floor space. The system should also be considered for smaller plants where continuity of service is of real importace. However, the load center scheme does involve the problems of high-voltage cables within the plant, and of metering.

The older radial system is simplest, has poorer voltage regulation with its longer feeders, and is only as flexible as the number of feeders used.

The arrangement of incoming primary lines depends upon expense warranted to ensure service reliability. The lowest cost layout would be that of a single line to a single transformer. Another primary feeder would be the next addition toward a more reliable service. To connect the second line to a separate transformer, with secondary ties normally open, would further increase reliability. It may be said that the ultimate scheme would be to use network protective equipment wherewith the secondaries are interconnected and all transformers normally share the load.



Many advantages for load-center distribution in industrial plants can be cited. Unit type substations such as this are used. Primary switching equipment is in cubicle at right; drawout circuit breakers are mounted in compartments at left. (General Electric photo.)

Industrial transformers may have to be overloaded for the duration, realizing that their life is being shortened. Our greater concern must be that production is imperative. In such cases, transformers may be equpiped with temperature alarms, or forced cooling by air blast or water spray may need to be resorted to. Oil will require more frequent filtering. Spare transformers should be made available.

Modern practice in the purchase of industrial transformers is to specify a factory-assembled unit substation. They come ready for connection, and are available with various arrangements of primary switches and secondary feeder breakers.

However, where a substation has to be built up on the job, perhaps the most important thought should be to separate services as far as practicable. For instance, use two 500 kva banks, with separate primary cutouts, and secondary switches, rather than one 1000 kva installation. The cost will be greater, but proper maintenance will be made possible. And, when the emergency has passed, one bank can be withdrawn and its losses avoided.

In the parallel operation of transformers, impedances should match or reactors should be used to give

Asbestos-cement conduit, light or heavy wall, with its threadless fittings and available from 2 to 6 inches in diameter, has found much favor where installed so as to be safeguarded against shock. Bends are erected quickly and neatly as shown here. (Johns-Manville photo.)

Conductors in multiple are being favored for heavy circuits and such circuits are made practical by the modern pressure connections available such as shown above. Below, one of the hydraulic tools for indenting lugs into conductors. This new method is rapid, economical, and provides joints of high efficiency. (Both photos courtesy of Burndy Engg. Co.)

a proper division of load. In one old plant, for example, the 500 and 300 kva banks are together good for only 748 kva because of unmatched impedances. By this simple expedient, idle capacity can be put to work. Transformer manufacturers will furnish such information.

In modernizing power supply, it generally works out best to use new locations, without disturbing the present supply. One large new plant has its vaults under the main floor of the factory right at the load centers, access being provided by an electrical tunnel. Such service equipment should be so located as to be protected from floods, trucking damage, and like hazards. To protect an outdoor substation from sabotage by rifle bullets, build a masonry wall around the structure.

In rewiring, the selection of secondary voltage is important because sometimes capacity can readily be gained by a change in the system. Stepping up from 220 to 440 volts can double the wiring capacity. Replacing a single-phase, 3-wire lighting system with 120/208-volt, 3-phase, 4-wire distribution increases capacity by 50 per cent, and in many instances the fourth conductor to be added might need only be a bare neutral. The 120/208-volt system is being used to excellent advantage where the load is largely composed of lighting, heating and small appliances.

To bring added capacity into a plant, we can follow the plan of employing up to six service switches (National Electrical Code, Section 2351). In this way, the existing switch or switches and their loads need not be disturbed.

Conductors and Connections

Rewiring calls for the selection of conductors from an almost endless list of variations of cable design based on location—indoor, outdoor, open, buried, etc.; on arrangement of conductor shape—concentric, stranding, etc.; on insulation —the National Electrical Code lists 19 types; on local condictions—heat, oil, and such. Where unusual conditions are to be met, it is sound advice to discuss your problems with cable manufacturers. Few industrialists can keep fully abreast of modern cable development.

Each plant should adopt standard stock sizes. The National Bureau of Standards last year approved the Simplification of Wire Sizes as follows: Stock sizes A. W. G., Nos. 14, 12, 10. 8. 6, 2, 1, 0, 00, 000, 0000; and 250,000, 300,000, 350,000, 400,000 and 500,000 cir mils. Larger cables to be available on order.

George Andrae, of the Electrical Committee of N.F.P.A., has suggested a standard for rubber-covered wire which would need only ten sizes as follows: A.W.G., Type R. Nos. 14, 12, 8, 4, 2 and 1; Type RH, Nos. 0, 0000, 350,000 and 500,000 cir mils.

In these times of material shortage, the use of modern non-metallic-sheathed cables should be considered. For small currents, use thin-wall insulated conductors. Up to No. 4/0 thin-wall synthetic insulation, Type SN, is approved. These suggestions have this in common—they cut down on the use of the non-current-carrying materials.

Rubber-covered wires are the most commonly used type in industry. In this group we have Type RW for moist locations, R for ordinary work up to 50° C., RP for 60° C. but little used, and RH for high current capacity and temperature 75° C.

In normal times, Type R loaded to capacity can be shown to be economical for carrying sustained loads on account of its lower I^2R loss and improved voltage regulation. In wartime, this consideration of economical power transmission gives way to the saving of precious copper. Type RH gives the same current capacity with less copper, and that also results in a conduit saving.

The I.A.E.I. *News Bulletin*, of January, 1941, in a study of comparative costs of conductors, showed that the cost per ampere of capacity of Type RH was lower than that of either Types RP or R.

It has been suggested, in view of the emergency, that the National Electrical Code be revised to again approve the greater current-carrying capacities of the 1937 edition. True, this would shorten the life of these insulations by their operation at higher than rated temperatures, but that would be part of our war effort.

Type RW can be a life-saver when rewiring. It replaces lead-covered cable and because of the absence of the lead sheathing, the resulting smaller diameter allows for larger-sized conductors.

Type SN has stood up well in machine shops. It offers the advantage of higher current rating over Type R by about 20%, and being thin-wall, saves on conduit, or in other words, allows for more conductors per conduit. When rewiring, the Code allows a 25% greater conduit fill.

Asbestos insulated conductors, or asbestos in combination with other insulating coverings, are available in many forms. Essentially, they are used in hot places, for circuits close to furnaces, over boilers, for fuel burner controls, rheostats and bunched wiring. Type A insulation is rated 200° C. These insulations are also installed in corrosive atmospheres where fumes would destroy rubber.

The paralleling of conductors has been approved as follows (National

Electrical Code, Interim Revision No. 39. 3008. Issued Nov. 25, 1941):

3008. Conductors in Multiple. Conductors in sizes 1/0 to 500,000 c.m., inclusive, may be run in multiple provided they are of the same length, have the same circular-mil area and type of insulation, and as few conductors as possible for the type of insulation are used. Except as herein provided conductors shall be run in multiple only by special permission or as permitted in section 6205. Where conductors are run in multiple, they shall terminate at both ends in pressure connectors so arranged as to insure equal division of the total current between all conductors that are involved.

Conductors in multiple are easier to install and give greater capacity than equivalent single conductors. It is generally agreed that conductors larger than 350,000 cir mils should not be employed for a-c circuits. Objections are that currents might not divide equally over the parallel paths, due to variations of resistance as at lugs. Furthermore, should one cable become open, the other might be ruined. Where extensive multiple installations are planned, it is modern practice to have cables reeled accordingly to save handling too many reels at one time.

Multiple lugs are available and they provide for the proper termination of parallel cables.

Modern methods include pressure connections, although solder lugs are favored by some in locations of extreme vibration.

In place of the removable pressure connectors, there are portable hydraulic tools, weighing 10 to 50 pounds, for indenting lugs into conductors. This new method is rapid, economical, provides joints of high efficiency, and is safe.

When rewiring, use insulating bushings and liners to prevent conductor failures at the ends of conduits.

Modern Wiring Methods

There is a new concept of wiring to bring conductors to the surface, where contact can be readily made. In this class are busways, wireways, surface raceways, and open wiring on insulators. This idea can be built into conduit system by the provision of numerous outlet boxes.

Open wiring is well suited as a feeder system to heavy loads. This system uses only conductors, porcelain or other insulators, and fastenings, and so saves on critical materials. Its current rating is higher than raceway systems, a No. 4/0 Type R being good for 248 amperes at 30° C. It should be installed out of harm's way.

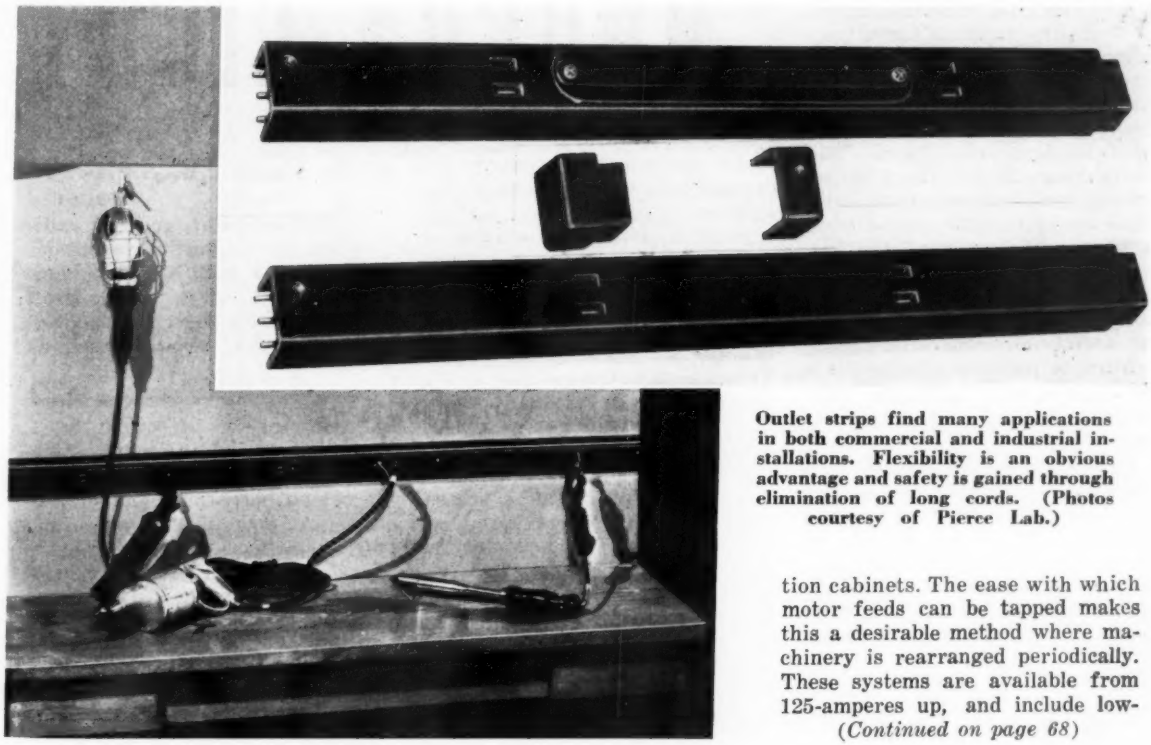
In industrial modernization, high-voltage armored cables are finding increasing application as circuits to load centers.

Steel conduit makes an excellent system but steel is needed for better purposes, so we must find substitutes. Electrical metallic tubing saves steel, or we can go to fibre or asbestos-cement conduit.

Asbestos-cement conduit, light or heavy wall, with its threadless fittings and available from 2 to 6 inches in diameter, has found much favor where installed so as to be safeguarded against shock. It is ideal for corrosive atmospheres and can be buried directly in the earth. Heavy wall fibre has the advantage of being less subject to breakage from mechanical shock.

Regarding E.M.T. (thin-wall conduit), Underwriters' Laboratories has approved the use of enamel coating because of the zinc shortage. A new tool makes joints by indenting the couplings to the tubing.

The busway method is popular. It's just as if the switchboard bus were extended around the plant until motor branch circuits could be tapped to it directly, thereby eliminating feeders and distribution cabinets. The ease with which motor feeds can be tapped makes this a desirable method where machinery is rearranged periodically. These systems are available from 125-amperes up, and include low-



Outlet strips find many applications in both commercial and industrial installations. Flexibility is an obvious advantage and safety is gained through elimination of long cords. (Photos courtesy of Pierce Lab.)

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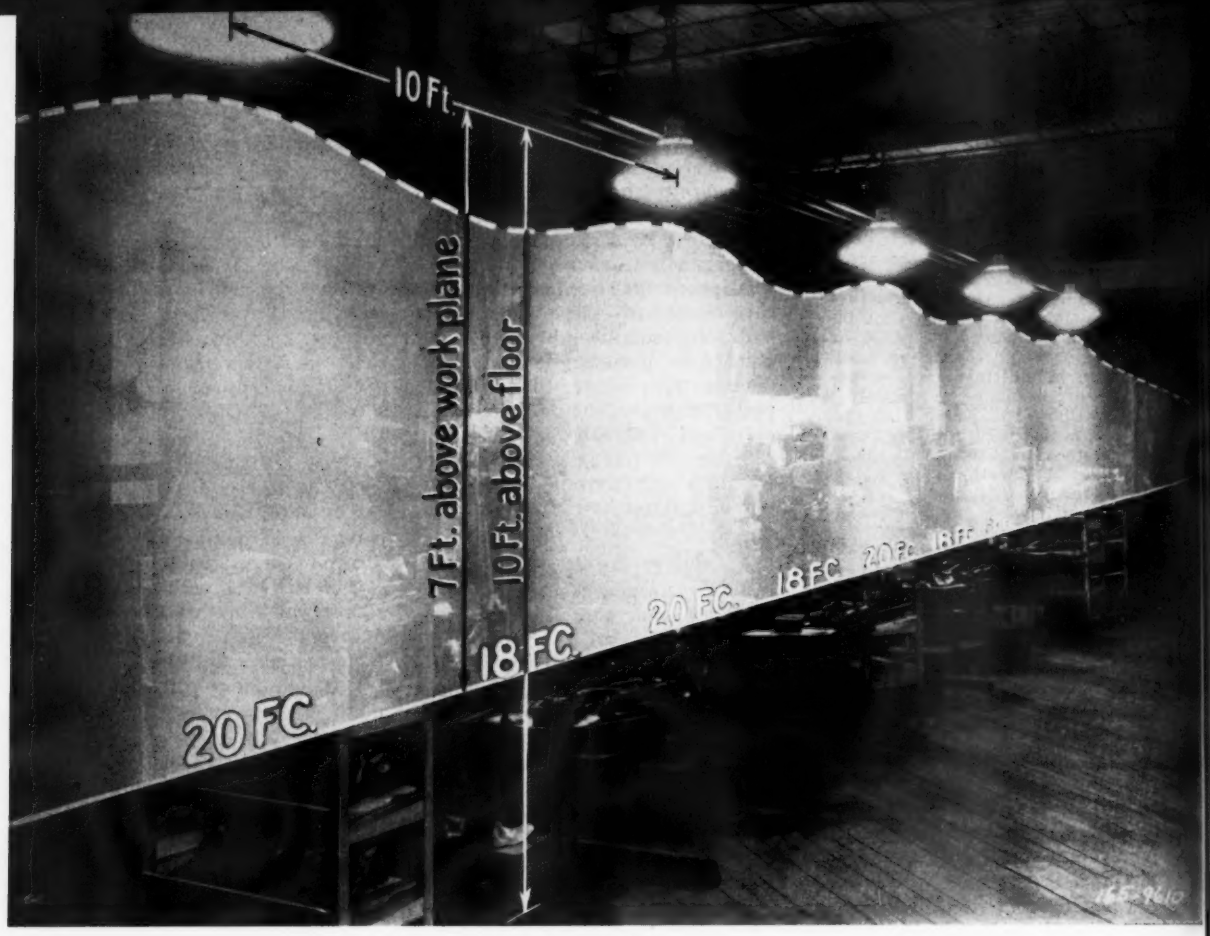

MODERN LIGHT

By Charles L. Amick*

These photographs indicate the difference between good and bad light distribution.

At left, the illumination throughout the work area is

WITH THE WHEELS of industry turning faster and faster to meet war-time demands, most plant operators are faced with the problem of increasing production either by (1) adding those modern equipments still available or (2) by otherwise improving manufacturing techniques to secure the most from existing facilities. If the plant is producing goods essential for the war effort, it is likely that the desired modernization equipment (including additional or more up-to-date lighting reflectors) will be available, but in many cases the latter avenue, (2), will be the only one open.

This article will discuss both possibilities, pointing out the new lighting equipment and methods now employed in industry and how to make the best use of the illumination system available when the modernization program just mentioned is beyond the reach of the plant operator. The latter discussion will, of course, be applicable to both groups.

Most industrial executives appreciate the value of modern lighting, for many of them recall the revelation disclosed by World War I that improved lighting brings benefits far outweighing its cost. These advantages—aiding in the improvement of product quality, increasing production, and decreasing spoilage, rejects, accidents, and maintenance cost—take on added significance at present when so many plants have been told that there is a need for "all that you can produce, and then some."

However, there are still other benefits of good lighting which are also of considerable importance in these times. For example, modern lighting helps inexperienced workers to distinguish clearly and comprehend the critical seeing tasks so often a part of manufacturing operations and greatly assists in making the evening and night shifts as efficient and accurate as possible. If factory windows have been blacked out, good general lighting will be essential during daylight hours as well.

There are a number of factors which influence the effectiveness of a lighting installation. Simply defined, a satisfactory lighting in-

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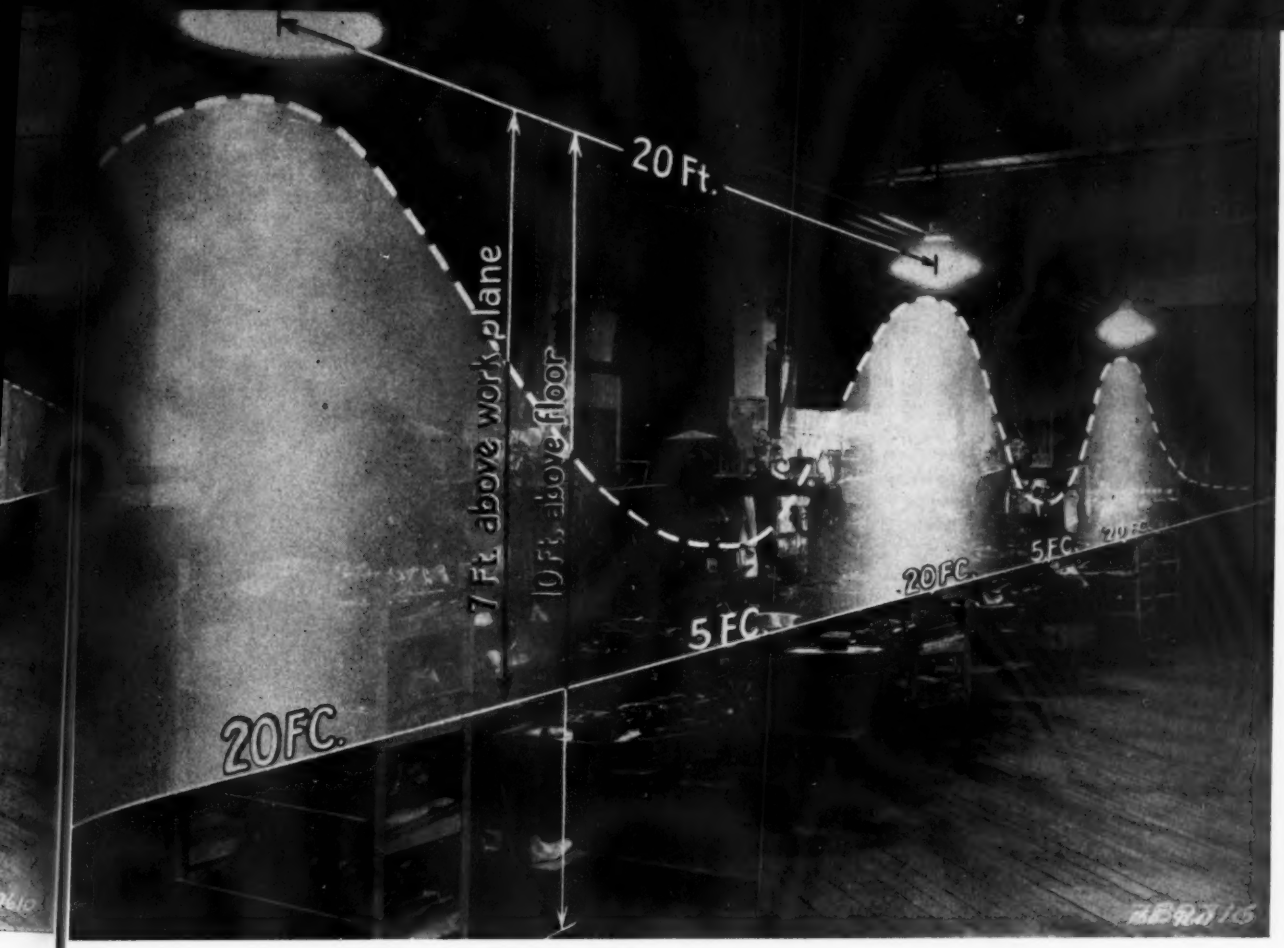


FOR INDUSTRY

reasonably uniform, and outlets are properly spaced.

At right, the "roller coaster" effect follows from units that are spaced too far apart for their mounting height thus resulting in poor distribution and difficult seeing.

stallation is one providing an adequate amount of illumination, comfortable as regards lighting quality and of a color pleasing to the workers and appropriate for the visual tasks.

The footcandle levels recommended for various types of industrial interiors depend on the character of the seeing tasks performed there. We know, for example, that small things are more difficult to see than larger ones. For this reason, 20 footcandles represent modern lighting practice for medium assembly work, 50 footcandles for medium fine assembly, and 100 or 200 footcandles for fine or extra fine assembly operations.

The visual task is more severe when it involves the discrimination of details on materials having relatively low reflection factors, that is, when there is little contrast between the seeing task and its background. Thus, 30 footcandles may be satisfactory for the cutting, inspecting and sewing of light cloth products while 100 footcandles would be recommended for similar operations involving medium colored goods, and 200 footcandles for dark goods. Of course, the economical attainment of some of these footcandle values may require the use of carefully planned supplementary lighting.

Another significant factor is the time available for seeing. Many industrial operations are now being speeded up to meet the demand of the war effort. Workmen are thus called on to perform their tasks more rapidly, yet with no sacrifice in quality or accuracy. Many do not realize that it takes time to see. Like a camera, the eyes can take "snapshots" when the illumination is high, but when the illumination is insufficient they must take "time exposures." Thus good light is vital when seeing must be rapid.

In appraising the existing lighting installation from the standpoint of quality or lighting comfort, there are several deterrents to look for. These include direct glare, reflected glare, non-uniformity of the illumination level over the work area and shadows. Both types of glare are not only uncomfortable but actually reduce the benefits of the useful light by lowering visibility and causing needless expenditure of the workmen's energy because of nervous tension and fatigue. Direct glare

Typical examples of use of supplementary lighting. At left, individual fluorescent bench units supply over 200 footcandles for critical seeing tasks. Below, supplementary unit recommended for lighting of gauges, micrometers and the like.

results from (1) the use of lighting equipment that directs an excessive amount of light to the eyes, and (2) units which are too bright because they employ lamps larger than those for which they were designed. Reflected glare is simply the mirroring of bright light sources by polished seeing tasks and is due to the excessive brightness of lighting equipment or to the improper location of units (particularly supplementary).

A good distribution of lighting means a fairly uniform general illumination throughout the working area, desirable because eye strain generally results if the workmen's eyes continually try to adapt themselves first to bright and then to dim areas. Poor distribution or "roller coaster" illumination is caused by units spaced too far apart for their mounting height and from failure to provide adequate general illumination along with supplementary lighting. Steps taken to produce fairly uniform illumination throughout the work area also usually eliminate harsh, dark shadows which slow up production, cause errors and constitute an accident hazard because they hide objects which should be seen.

While a careful appraisal of the lighting system will reveal the presence of any of the forementioned obstacles to quick and easy seeing, other symptoms may also indicate improper lighting quality or quantity. For example, if some employees get tired more quickly than others, it may indicate poor uniformity of illumination. If employees complain of headache, an insufficient footcandle level or glare conditions may be contributing factors.

Improving or Replacing Existing General Lighting Systems

The footcandle level of existing lighting systems can be increased by (1) substituting appropriate reflectors which better utilize the light, (2) substituting reflectors designed for and employing higher wattage lamps, (3) adding units between existing outlets, and (4) complete revamping of the installation and using modern luminaires located to give the footcandle level desired. It will sometimes be found that the latter approach is the most satisfactory and yet still economical, especially if extensive rewiring costs are involved in boosting the illumination level by the other methods suggested.

Adding additional reflectors of the type already installed is practical in certain cases. For example, a low-bay installation of units, say on 10 x 10 foot spacing, could be greatly improved by adding rows of luminaires between existing rows, the new reflectors being located so as to be seven feet along the diagonal from each of the previously installed units. Thus, the illumination (except along the side walls) would be doubled.

If the plant operator decides to improve his lighting by completely revamping the installation, any of the illuminants can be considered. Fluorescent lamps may be selected in some cases—filament or mercury lamps in others.

In the four years since fluorescent lamps were introduced, many industrial managers have familiarized themselves with the characteristics, advantages, etc., of Mazda F (fluorescent) lamps. Hundreds of factories have been relighted with this new source because it is somewhat of a "natural" for industrial lighting. The logic of such a statement will be apparent when the illumination level and lighting quality improvements made practical by the fluorescent lamp are considered.

The former advantage results from the higher efficiency of fluorescent lamps — permitting roughly double the footcandle level on the existing wiring capacity if power factor corrected flu-

orescent auxiliary equipments are employed; the lighting quality advancement is due to the lower brightness and increased size of the light source. The lighting quality improvements include increased diffusion, less direct and reflected glare, and the elimination of harsh, sharp shadows.

A variety of single- and multiple-lamp industrial fluorescent reflectors are now on the market. Some units, such as the RLM fluorescent reflector, have closed ends, others are open. The closed end design gives some endwise shielding, desirable particularly in continuous-row installations at low mounting heights. In many of the latest designs, the reflector can be easily detached and taken to the floor for proper cleaning.

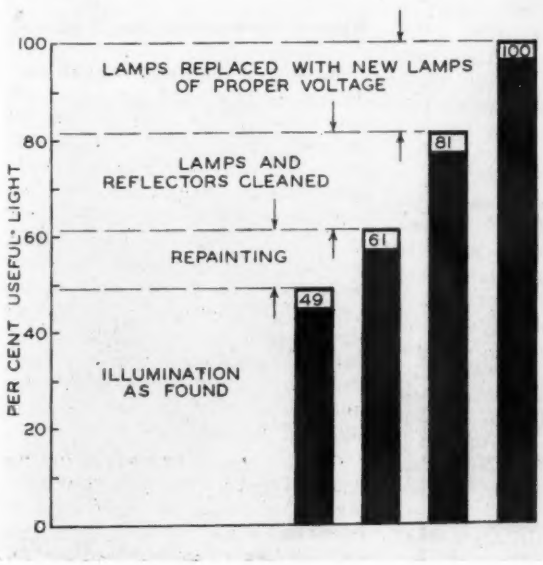
Modern industrial fluorescent lighting practice appears to be standardizing on systems using continuous rows of units located crosswise to the normal viewing direction of the majority of workmen. The wiring channel is continuous, carrying all the ballasts, compensators, starters, starter sockets, and lampholders and also simplifying the lighting-system wiring since only one power connection is required and that can be made at any convenient point along the row.

The accompanying table indicates the average footcandles in service obtained with continuous rows of 40- and 100-watt RLM equipment in the small, medium and large interiors and with typical ceiling and wall reflection factors. The really progressive installations are going in at 50 footcandles or more but the continuous row system is quite flexible from the standpoint of the desired illumination level.

For example, empty spaces can be left by omitting every third or fourth reflector. The cost of installing these reflectors later when the additional illumination level is desired will be relatively low, since channel and wiring are already in place. Another possibility is the use of reflectors having lampholder openings punched for an additional lamp which, in the case of a two-lamp industrial unit, will inexpensively enable a 50 per cent footcandle boost when the third lamp is added. And besides being flexible, continuous-row installations are economical, have a pleasant appearance, often improve the visibility of the seeing task (particularly those involving specular convex surfaces common on industrial machinery) and are easy to install and maintain.

The footcandle levels can also be considerably improved in many instances by installing the proper fluorescent equipment at existing outlets. For example, in a typical-sized factory area, the replacement of filament luminaires on 10 x 10 foot spacings with RLM fluorescent reflectors employing two 100-watt white fluorescent lamps in each would produce about 40 footcandles in service. On the other hand, a weakness of the conventional unit installation of industrial fluorescent equipment is the tendency to install the new luminaires at the same outlets but under conditions which give little or no additional illumination and therefore no significant improvement in lighting effectiveness.

A new light source which has only recently been made available is the 3,000-watt mercury lamp. Known as the A-H9 lamp, this new source is about 55 inches in overall length and has a tubular bulb slightly less than 1¼ inches in diameter. The lamp produces approximately 120,000 lumens initially and has a rated average life of 2,000 hours. Some fixture manufacturers have already listed equipment for this new lamp — such units should be particularly well suited for high bay areas, es-



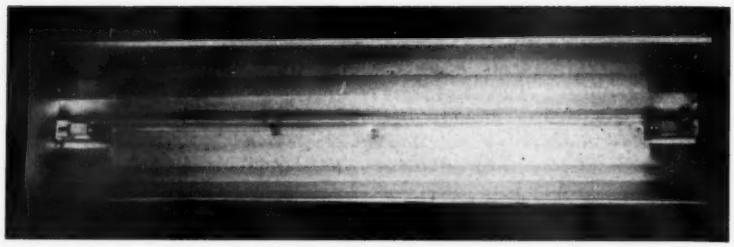
This chart indicates the striking improvements which can be obtained by repainting and cleaning lamps and reflectors. Note that useful light was more than doubled.

The thorough, frequent cleaning of reflectors required for adequate maintenance of a lighting system can be most effectively accomplished by washing them on the floor.

pecially those of steel plants, foundries, heavy-duty erection shops, locomotive-repair plants, etc.—wherever high level illumination is desired at such mounting heights with a minimum number of fixtures.

The high light output permits a reduced number of fixtures and means that the maintenance costs will be lower in a specified area for a given footcandle level. Incidentally, the three-kilowatt mercury lamp has the light output of about 7½ of the well-known 400-watt H-1 mercury lamps. And the cost of light in dollars per footcandle year is somewhat less than for any other illuminant.

Whatever the method used to increase or completely revamp existing lighting installations, there are several installation units which may be of value in executing the new design.



Looking upward into a 3000-watt H-9 mercury unit.

(1) **Using higher voltage to increase wiring capacity.** Frequently, filament-lamp installations can be changed to use higher-voltage lamp by a simple connection at the lighting system distribution panel. Wattage capacities can be increased 100 per cent by a 240- instead of a 120-volt distribution. In addition, for a given wattage load, such higher voltage distribution affects a 50 per cent reduction in the line voltage drop and a 75 per cent reduction in the wiring power loss for a given wattage load.

(2) **Locating fluorescent fixtures.** Since most industrial fluorescent luminaires have their maximum shielding (protection from direct view of the lamp) in the direction at right angles to the lamp axis, such equipment should generally be positioned so that the lamp axis will be crosswise to the predominant normal viewing direction.

(3) **Luminaire efficiency.** There is little excuse today for low fixture efficiency.

(4) **Above all, watch out for comfort.** An installation which merely achieves specified footcandle levels at the sacrifice of comfort to those who must live with the installation is neither economical nor acceptable. Today's production demands calls for an abundance of *comfortable* lighting.

Average Footcandles in Service For Various Spacings of Continuous Rows of RLM Fluorescent Reflectors Each Using Two 40-watt White MAZDA F Lamps*

Spacing of rows on Centers, Feet	Average Footcandles in Service with typical wall (50% Reflection Factor) and ceiling (30% R.F.) finishes*		
	Large Room	Medium Room	Small Room
6	82	70	55
8	61	52	42
10	49	42	33
12	41	35	28
14	35	30	24
16	31	26	21
	Continuous rows of RLM Fluorescent Reflectors each using two 100-watt white MAZDA F lamps**		
8	87	75	60
10	70	60	48
12	58	50	40
14	50	43	34
16	43	38	30
18	39	34	26
20	35	30	24

*Because of lamp and reflector depreciation, the initial footcandle level will be appreciably higher.
**Footcandle levels will be about 15 per cent lower when using daylight lamps.

What About Supplementary Lighting?

Modern illumination level recommendations must be based on character of the seeing task. If the task is severe from the standpoints of contrast with its background, size or the time available for seeing, the footcandle level should be relatively high. Such levels must often be economically obtained by the use of supplementary lighting carefully applied to those specific seeing tasks. It is called "supplementary lighting" because it should supplement (and not supplant) an adequate general lighting system.

Good supplementary lighting systems must be studied and designed with just as much or more care than required for executing a satisfactory general lighting installation. Severe local seeing tasks must be adequately lighted without causing glare or discom-

(*Continued on page 66*)

Selection of Modern Motor Control

A-C

By W. R. Holmes*

FUNDAMENTALLY, there are two ways of starting a-c motors, (1) by connecting them directly across the line, or (2) by some means of reducing the voltage applied to the windings. These methods may be further separated into manual and automatic operation.

Broadly speaking most a-c motors can be started directly across the line. To what extent this is desirable depends upon the permissible disturbance of line voltage, current inrush, etc.

For all practical purposes, starting motors directly across the line is usually limited to motors up to and including those of 5 horsepower. In the fractional-horsepower sizes, starting is usually accomplished by means of an ordinary switch that connects or disconnects the motor from the line. Some starters within the 5 hp. range are furnished with protective devices, small thermal units, built within the enclosure which act as overload protectors, disconnecting the motor from the line when its current input exceeds, for a period of time, a given value. On low voltage or voltage failure the motor stops but automatically returns to operation when normal voltage is again established.

Overload protection usually consists of a series winding connected directly in the leads to the motor. These serve to trip a set of contacts thus opening the main line contactor on overload. Two such relays are required for three phase motors. Each relay has a time delay feature. This operates by the heating up of a thermal element or by "pulling-in" a dash pot which allows enough time for the motor to start without tripping on the inrush current.

Starters equipped with overloads are ideal for fans and blowers and applications of a like nature but are unsuited to machine tool operation where voltage failure leaves the operator exposed to injury due to the unexpected starting.

Where the motor is applied to a lathe, press or similar machine or subject to conditions existing in the applications mentioned, the starter should be equipped with low voltage protection which does not restore the motors to operation until precautionary measures have been taken or the start button is again pressed.

Manual starting is also accomplished by the introduction of resistance in the rotor circuit as with wound rotors having collector rings or by using a transformer having low voltage taps which are interconnected to the motor, and also by star and delta connections whereby low voltage is impressed on the motor at starting and full voltage applied when the motor reaches normal speed.

These manual control methods are performed automatically by the use of magnetically operated relays and contactors as described here in more detail.

In automatic motor starting, all the functions of starting and bringing the motor up to speed are initiated by pressing a button or by the operation of some such pilot device, energizing the magnetic circuit and completing a sequence of operation as in manual controls.

Automatic across-the-line starters consist briefly of a magnetically operated switch and an overload relay. The operating or magnet coil can be controlled by a push button, pressure switch or any pilot device which may be operated locally or from some remote point. The wiring diagram, Fig. 2, shows the coil controlled by a three-wire start-stop push button station which needs only momentary pressure on either button.

Starting a-c motors on reduced voltage by inserting resistance in the motor circuit and known as

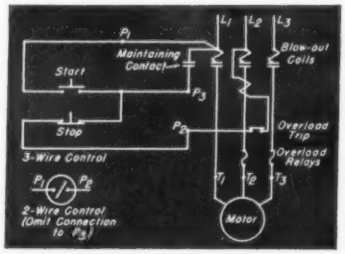


Fig. 2. Wiring diagram of the across-the-line type starter.

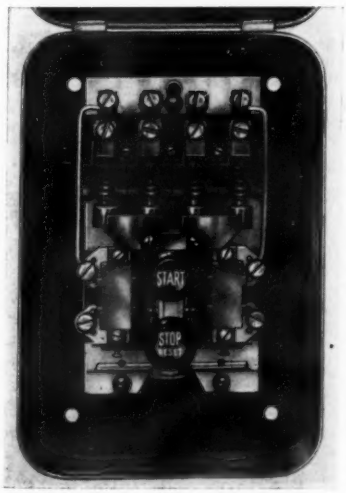


Fig. 1. Manual across-the-line type starter with thermal over-load protection.

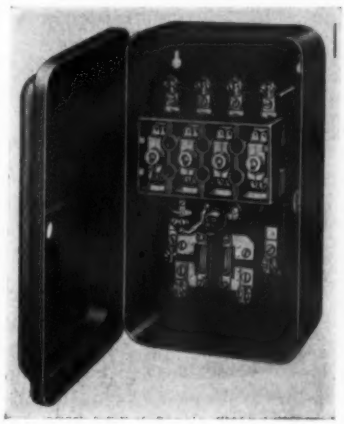


Fig. 3. Small a-c automatic across-the-line starter.

*Mr. Holmes is sales engineer for Ward Leonard Electric Company, Mount Vernon, New York.

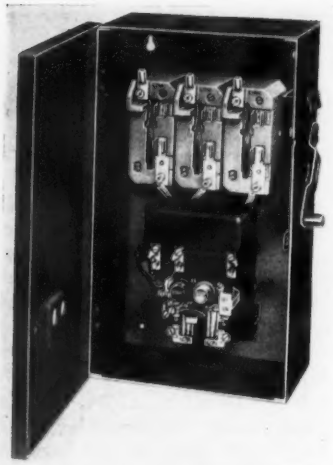


Fig. 4. Starter with motor disconnect switch in the same box.

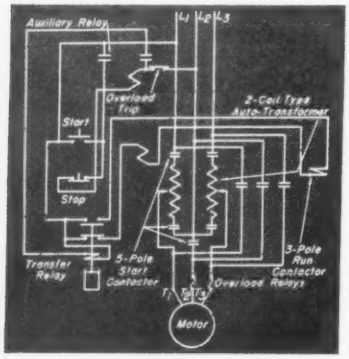


Fig. 7. Wiring diagram of the auto-transformer starter.

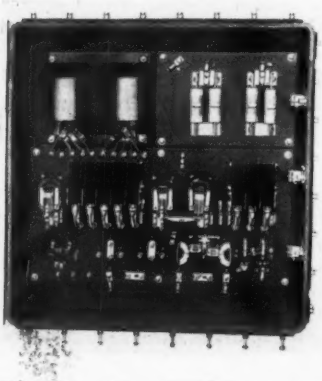


Fig. 8. Auto-transformer type starter in water-tight enclosure.

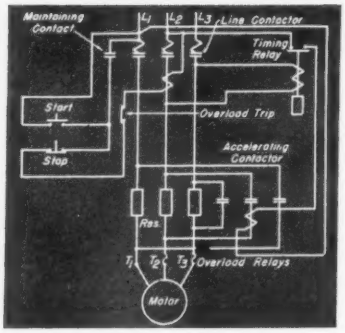


Fig. 5. Wiring diagram of resistor type starter having contactors to short out resistors.

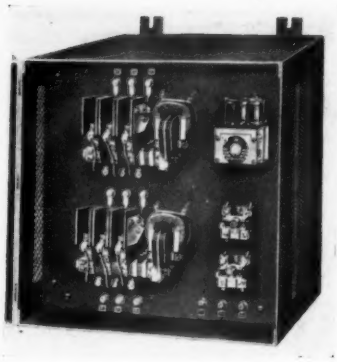


Fig. 6. A-c automatic starter of primary resistor type.

the "primary resistor" method is one in common use. This method employs resistance in the primary or stator winding which permits starting the motor on reduced voltage. As the motor gets up to speed an accelerating contactor shorts out the resistance, impressing full voltage on the motor winding (see Fig. 5).

The motor circuit is not opened during the starting period in this method and since the voltage drop across the resistance gradually decreases as the inrush current decreases the line disturbance is smoothed out thus providing a double feature to this method.

In the auto-transformer method of motor starting, several taps on the auto-transformer winding provide a choice of voltage to obtain the desired starting torque. The pilot switch closes the line contactor energizing the motor through the selected reduced voltage taps. When the motor reaches approximately normal speed, a transfer relay switches the line voltage from the reduced voltage taps to the full voltage or "run" position. A fairly appreciable line disturbance takes place during this transfer. The advantage in this method, however, is the low current drawn from the line.

The secondary resistor method, as applied to slip ring motors, inserts resistance in the secondary or rotor circuit of the motor. The rotor circuit in this method is subject to the same conditions of starting as in the primary resistance method (see Figs. 9 and 10).

In the star-delta method of starting a-c motors, the first contactor to close impresses a voltage equal to 58% of the line voltage across the star-connected motor winding. The second contactor to close impresses line voltage across the motor winding which is now connected in delta.

The disadvantage of this method is the limitation of starting torque by a fixed amount, 58% of the line voltage, which may be insufficient on applications where a heavy starting load exists.

With the exception of the secondary resistor method of starting a-c motors, the previously described methods can be used in starting a synchronous motor.

A synchronous motor is usually started "light." If the motor is driving a generator, a compressor or any other such machine, the machine load is often removed or disconnected during the starting period.

These motor starters, in addition to the necessary contactors, relays, etc., must have an additional contactor to apply the d-c field. The time at which the d-c field is applied can be determined by one of several methods. The "slip freqency" method makes use of a relay actuated by a low frequency which connects the field circuit to the d-c source at approximately full synchronous speed.

Another common method makes use of a definite time delay relay which applies the d-c energy to the field circuit after a definite time lapse.

Squirrel-cage type induction motors are reversed by reversing the motor leads. This is done by switches so wired that by pressing a button the reversal is accomplished. The starter shown in Fig. 13 for across-the-line starters up to 5 hp may be wired with a three button starter marked "Forward-Reverse-Stop."

The control circuit can be arranged so that the "stop" button must, or need not, be pressed at each motor reversal. It may also be so wired that the motor runs only while the button is held down.

Plugging is the action of bringing the motor to an abrupt stop

due to a reverse torque. This can be applied to squirrel cage type motors and most wound rotor motors without damage to them.

The straight squirrel-cage type induction motor does not lend itself well for speed control by a resistance type regulator. Inserting resistance in the incoming circuit, thereby cutting down the voltage to the motor, does reduce the speed of the motor but with great loss in efficiency. Straight squirrel cage motors are, however, used on many machine tools where a change in speed is required, but in such cases, the speed is changed by means of a set of gears, various belt connections, or by the use of hydraulic couplings, and not by speed control of the motor itself.

Some straight induction squirrel-cage type motors have two or three separate windings on the stator, or else have one winding arranged so that it can be reconnected. A speed regulator for this type motor consists merely of a group of contactors which connect the supply line to the desired winding for the desired speed. On single winding motors (consequent pole type), the contactors are used to rearrange the connections so that the motor has a different number of effective poles.

On multi-speed controllers of this type designed for constant or variable torque loads, separate overload relays are furnished for each speed. The windings on low speed are designed to carry less current than on high speed. Fig. 14 shows one of these controllers which may be operated by a push button station or pilot switch.

Wound rotor or slip-ring motors lend themselves readily to speed control. A standard across-the-line starter connected in the primary circuit and a three-phase balanced adjustable resistor in the secondary circuit provides the necessary control.

Speed regulators of the resistance type operate on the principle of reducing the voltage to the motor through a loss or voltage drop across the resistor. The voltage drop depends upon the current flow and this in turn upon the connected load, the amount of speed reduction then for any given resistor corresponds to the motor load. Thus the type of motor load, whether fan or machine, determines the type of resistor to be used in speed regulation.

Speed regulators are divided into two general classes: (1) constant torque such as machine tools, and (2) variable torque such as fans. This time is determined by test and allows ample time for the motor to reach approximately full speed.

A rheostat connected in the field circuit of synchronous motors to control the field current permits improving the power-factor. Increasing the current results in a "leading" power factor load, a decrease in the current causes the power-factor to "lag."

Another feature often found in synchronous motor starters is that of stopping the motor or restarting it should a sudden increase in load or a sudden drop in voltage pull it out of "step." This is also accomplished by the use of relays which respond to the change in frequency in the field winding or to the change in the power-factor of the motor load.

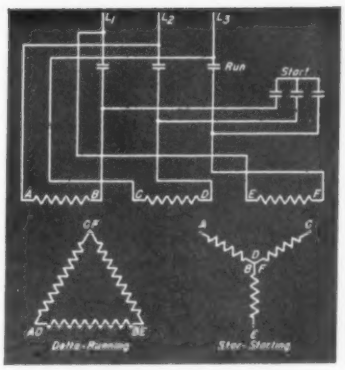


Fig. 11. Diagram for the star-delta method of starting.

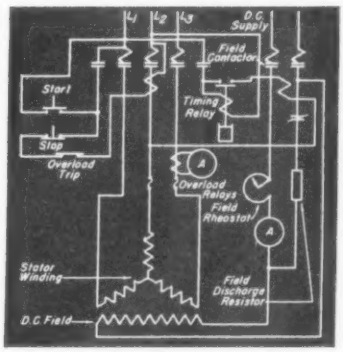


Fig. 12. Wiring diagram for a synchronous motor starter.

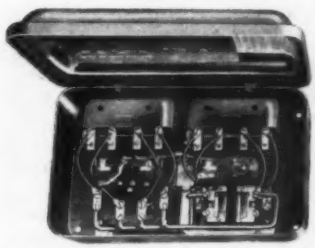


Fig. 13. Across-the-line reversing controller for a-c motors.

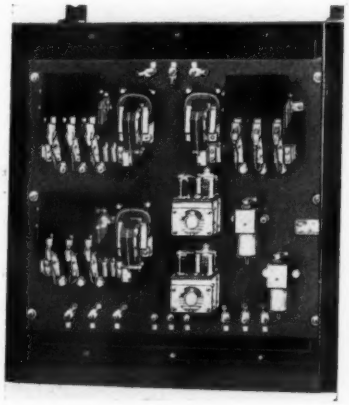


Fig. 9. A 25-hp secondary resistor type starter.

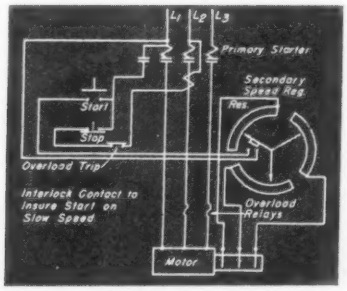


Fig. 10. Wiring diagram for secondary resistor starter shown at left. Applied to slip-ring motors, this type of starter inserts resistance in the secondary or rotor circuit of the motor. This type of starter provides automatic acceleration with minimum disturbance.

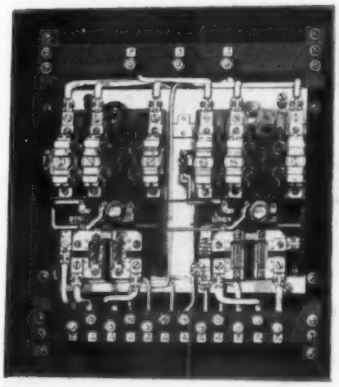


Fig. 14. Across-the-line starter for two-speed motors.

Selection of Modern Motor Control

D-C

By J. H. Lewis*

THE GREATLY increased use of direct-current motors particularly where speed adjustment is required, makes d-c control a subject of increasing importance to plant engineers. An understanding of the basic principles of d-c control is valuable in selecting the right controls—and hence in getting the best performance from the motors with which they are used.

D-c control is easily understood. By means of a foot pedal the sewing-machine operator starts and varies the speed of a 1/20-horsepower sewing-machine motor. A blooming-mill operator controls an 800-horsepower mill motor—also with a foot pedal. A machine-tool operator presses a button to quickly change the speed of a motor from 900 to 1800 rpm. In each of these cases, the same general principles apply, but the controls differ according to the motor and the requirements of the application.

A few of the functions which d-c controllers are commonly called upon to perform for a motor are:

1. To start the motor.
2. To limit current during starting.
3. To protect motor in case of overload.
4. To protect operator from unexpected restarting after failure and return of power.
5. To adjust speed of motor.
6. To stop motor quickly.

As will be seen later, controls can be obtained to perform almost any one of these functions or all of them.

Types of Control

Controls differ in the manner in which they are operated. In general, all d-c controls fall into the following three classes:

(1) Manual Controls: All basic functions are performed by the operator as he moves the handle. A good example is the manually operated dial switch.

(2) Semimagnetic Controls: Certain functions are performed by hand, while others are done automatically. A good illustration of this is a drum controller with a protective panel. With this control, the operator manipulates the handle of the drum switch to vary resistance in the circuit. A magnetic contactor makes and breaks the connection to the power source.

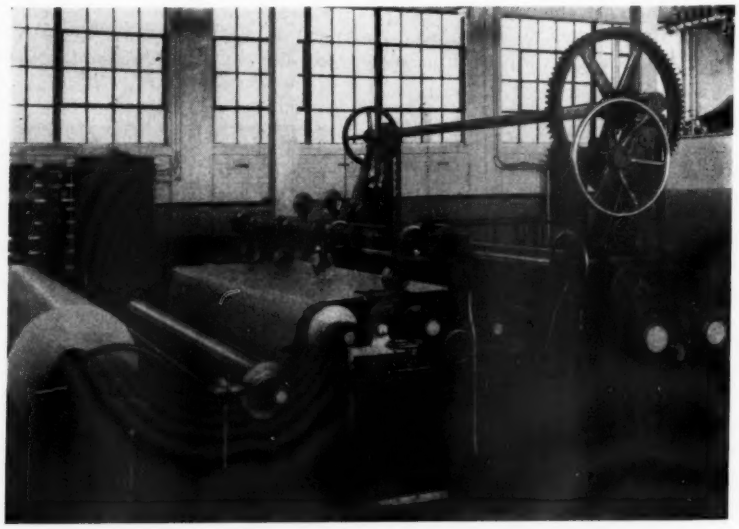
(3) Full-magnetic Controls: All control functions are performed by magnetic devices. The operator simply presses a button, and the controller does the rest. Such controls can also be made to operate from a float switch, which operates when a change takes place in the level of a liquid, or a pressure switch, which functions with change in pressure. Limit switches and other pilot devices are available.

In general, manual controllers are recommended only for small motors, or for applications where operation is infrequent. For larger motors, manual controllers are large in size, difficult for the operator to use, and more costly to maintain than magnetic controllers which would perform the same function. Even for small motors there has been a definite trend in recent years toward full-magnetic control. This is because (1) magnetic control is easier to use and does not fatigue the operator; (2) it minimizes the operator responsibility; (3) it protects the motor and the driven machine more completely by limiting to a safe value the rate at which the motor can be accelerated; and (4) on severe duty the magnetic controller requires less maintenance than corresponding manual controllers.

Methods of Controlling Motors

A brief review of d-c motor principles at this point may be helpful in clarifying the explanation of d-c control.

Unlike a-c motors, none but the very smallest d-c motors should be started by applying full line voltage to the motor. This is because the only factor that limits the initial starting current is the resistance of the armature winding, which is relatively small. However, as a d-c motor accelerates, it acts as a generator, producing a voltage which opposes the applied voltage. As this voltage builds up, it reduces starting current un-

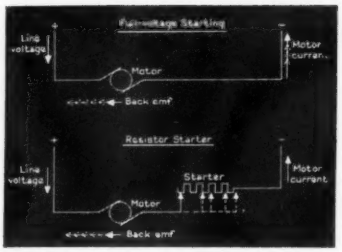


Drum switch, at center, starts and controls speed of direct current motors driving this winder in a parchment plant.

*Mr. Lewis is connected with the Industrial Control Engineering Department, General Electric Company, Schenectady, New York.

til, at full speed, normal running current is reached.

Since the motor must be running to generate this "back emf" as the opposing voltage is called, it is non-existent when the motor is at standstill. If full voltage were applied directly to the motor, current and torque would be excessive, and the motor or driven machine might be injured.



Therefore, in starting a d-c motor, a resistor is put in series with the armature to limit this current. As the motor accelerates to running speed, this resistance is decreased.

There are several ways in which this can be accomplished. On dial-type starters a handle moves a contact over points on a dial switch to which a resistor is connected. Each point on the dial switch cuts out one section of the resistor.

In a drum switch, the drum segments short circuit successive blocks of resistance as the handle is moved to the full "On" position.

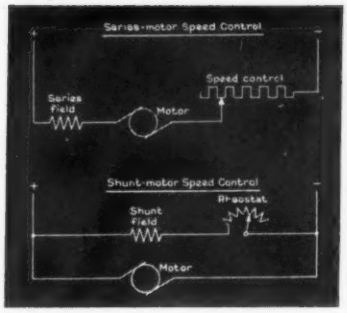
On a magnetic controller, blocks of resistance are likewise shorted out of the motor circuit; but in this case time-delay relays automatically govern the rate at which resistance is cut out, and the operator needs only to press the "Start" button to begin the operation.

Speed Control

One of the greatest advantages of direct-current motors is the ease with which their speed can be adjusted. There are several ways of doing this. The choice depends largely on the application, the range of speeds desired, and the type of motor.

On series motors speed can be reduced by inserting resistance in series with the armature.

On shunt- or compound-wound motors speed is usually controlled by a rheostat in the shunt-field circuit. Decreasing current in this circuit increases the speed of the motor. Motor speed can be



reduced by inserting resistance in series with the armature.

Manual controllers (either drum or dial type) are available which provide starting and speed reduction by resistance in series with the armature. Similar controls provide for increasing speed by placing resistance in series with the shunt field; and still another control provides for both speed reduction and speed increase.

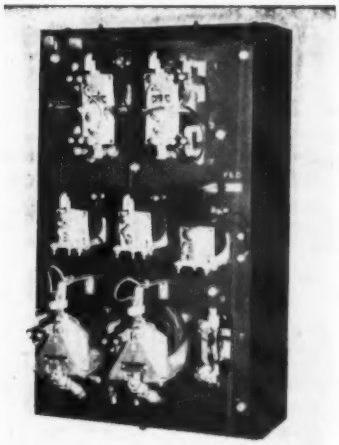
Protection Provided

Most controllers are provided with overload protection, to guard the motor against burning out. Current flowing to the motor passes through a "heater" which will carry the rated current continuously but which will heat with excessive current. This heating deflects a bimetal strip, composed of a pair of metals having different coefficients of expansion which are firmly bonded together. Excessive or prolonged heating causes this strip to bend, tripping a relay which shuts down the motor before the windings can be harmfully overheated.

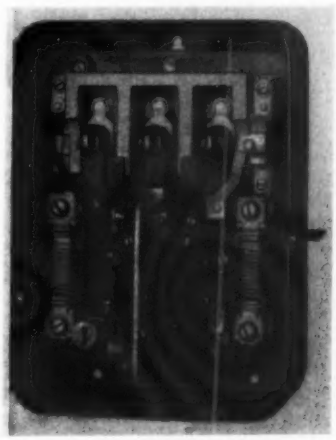
When the motor is shut down by this overload relay, the operator is warned of incorrect operating conditions and can check the connected machinery, bearings, and supply voltage before returning the motor to service. Overload protection does not in any sense take the place of short-circuit protection, however. Fuses or a circuit breaker should always be provided for protection against instantaneous high values of current in case of a short circuit in the leads or the motor.

In case of a voltage dip or power failure a motor will, of course, stop. Such stoppage may lead an operator to inspect his machine, check the gearing, etc. Obviously, if the motor restarts automatically, the operator may be endangered. Also, if power returns, a

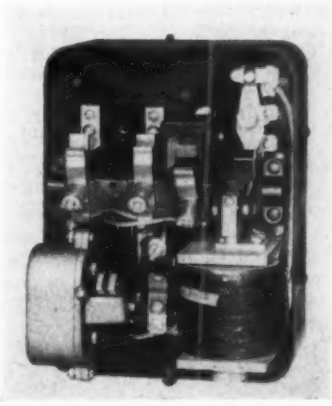
(*Continued on page 64*)



This starter times motor acceleration by magnetic means and provides adjustable speed, jogging, reversing and dynamic breaking.



This starter is applicable where power supply and motor are suitable for full-voltage starting.



This is a small, inexpensive general purpose magnetic starter. A push of the button and starter accelerates motor automatically.

Circuit Protective Equipment

Selection of circuit protective equipment is intimately related to industrial plant distribution system design. A review of general considerations as well as corrective measures for existing installations are discussed here.

By N. L. Hadley*

A DISCUSSION of the circuit protective equipment for industrial plants involves consideration of the whole power distribution system of which the circuit protective equipment is only a part. Repeated reference will be made to desirable distribution system characteristics, so these are listed below:

(1) Low first cost.
(2) Safety.
(3) Service reliability.
(4) Low operating cost.
(5) Good voltage regulation.
(6) Ease of operation.
(7) Growth flexibility.

It is evident that the circuit protective equipment does have an important effect on certain of these characteristics. It is not so evident perhaps how the protective equipment has at least an indirect effect on every one of them. The following list of general functions of circuit protective equipment assists in understanding these indirect effects and will be helpful later in reviewing the circuit protective devices themselves.

1. To limit damage to electric apparatus and conductors in the event of circuit faults.
2. To confine the effect of circuit faults (by isolation or transfer) to the minimum amount of apparatus.
3. To isolate or transfer circuits for safety during maintenance periods.
4. To reduce hazards to working personnel in the event of circuit faults.

The comments thus far can be regarded as background for considering the adverse effects, on the cost and value of circuit protective equipment, that can be caused by the arrangement of the distribution circuits and the ratings of distribution apparatus.

In many industrial plant distribution systems these effects can be shown to have introduced serious shortcomings into practically every desirable overall system characteristic. Because these effects can sometimes be found in relatively new plants or in proposals for new plants, it seems well worth while to illustrate in general terms the direct cause, with suggestions for corrective measures that might be adopted in existing installations.

At progressively higher short-circuit currents, circuit protective equipment having an interrupting function will tend to cost increasingly more. Where the relation of the short-circuit current to the normal current is unusually high —for example, where the interrupting requirement in a feeder supplying a 100-ampere load is 100,000 amperes—the economic burden of adequate circuit protective equipment may well appear to be unreasonable. In fact, it may be impossible to provide a complete practical system of protection in a distribution of poor basic design.

It should not be understood that an attempt must be made in system design to keep short-circuit levels to a single standard level, because a given level will seem disproportionately high only in relation to loading of feeders or branch circuits. The underlying causes of unnecessarily high short-circuit current possibilities in the distribution system can be studied as a step toward considering how they may be avoided or reduced if they already exist.

Generators and transformers are, of course, the source of short-circuit currents as well as the normal currents of the distribution system. The short-circuit current that can be produced by a generator or transformer of a given voltage rating is primarily a function of its rated capacity, and for the purpose of this article it can be said that the short-circuit current varies approximately with the rating. In other words, if a 1000-kva, 480-volt transformer can produce a short-circuit current of 33,000 amperes, a 2000-kva, 480-volt unit will produce approximately twice as much current but actually about 59,000 amperes.

There is not nearly so much likelihood that unreasonably high short-circuit levels will be reached through the selection of too large a generator or transformer as there is through the parallel operation of units. When two or more units are connected to the same bus, the short-circuit current will be the sum of the contributions of all

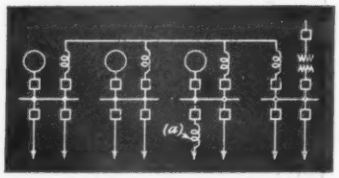


Fig. 1. One-line diagram of synchronizing bus in large industrial plant, generating major portion of power requirements.

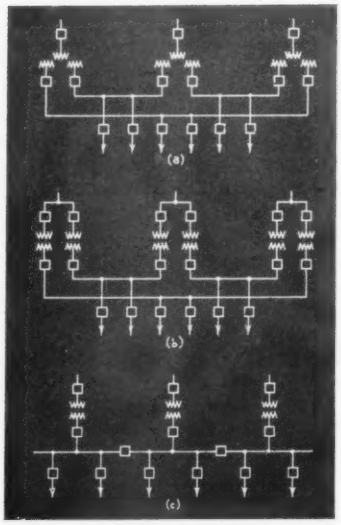


Fig. 2. Alternative substation arrangements for transformer power supply to a large industrial plant.

*Mr. Hadley is connected with the industrial engineering department of General Electric Company, Schenectady, New York.

the units; and this sum becomes the interrupting requirement of the circuit protective equipment in the feeders connected to that bus.

Where solidly bussed transformers or generators are found in an existing industrial plant, and the feeder circuits have not been adequately protected against the resulting higher short-circuit current level, the arrangement can be assumed to have resulted from failure to recognize changing circuit requirements as new units were added to accommodate a growing load.

Fig. 1 illustrates a synchronizing bus for successful parallel operation of generators in a large industrial plant. Regardless of the number of generators, the feeder short-circuit duty can be kept within about 200 per cent of the duty on an isolated bus section. One or more transformer supplies can be connected to the synchronizing bus, as indicated in Fig. 1. Duplex reactors and double-winding generators are other forms of bus sectionalization used for generating stations, although they are not nearly so common in industrial plants.

Fig. 2-a shows a very excellent form of bus sectionalization sometimes employed by a large industrial plant with no generating capacity. The arrangement shown produces the highest order of service reliability under various emergency conditions, and does this with a reduction of about 60 per cent in the short-circuit current that would be produced by connecting the same total transformer capacity to a single bus. The special feature of the arrangement illustrated is the three-winding transformer which provides an economical means of obtaining duplicate supply to each bus section with a fixed interrupting requirement regardless of the addition of more transfomer capacity.

Fig. 2-b shows a corresponding substation employing conventional two-winding transformers of the same total kva as those illustrated in Fig. 2-a. The secondary systems are essentially identical, but the cost of the transformers and their primary protection is materially higher.

In Fig. 2-c is a still more conventional arrangement for comparison with 2-a and 2-b. The main operating compromise is a temporary power outage on one bus in emergencies until the faulty unit is disconnected and the proper normally open bus-tie breaker is closed. The chances are good that this arrangement would have a slightly lower first cost than arrangement 2-a; but for particular conditions, the cost could be higher due to the higher normal current ratings of the five secondary main and tie breakers in comparison with the ratings of the six secondary main breakers in arrangement 2-a.

Of more practical interest in a modernization program would be the possibility of sectionalizing the secondary buses of two or more transformers by means of secondary tie breakers as used in Fig. 2-c. Such an arrangement would be indicated as a probably desirable change if these three transformers had been solidly connected to the same bus where the increased short-circuit duty had greatly exceeded the interrupting ratings of the original feeder breakers.

This arrangement, of course, allows carrying the entire load with a failure in any line or any one transformer, provided an adequate amount of spare transformer capacity has been included in the total kva rating of the units. If the spare capacity is not available, load curtailment would be necessary for emergency operation.

For supplying low-voltage (600 volts and below) load, the concentration of capacity suggested by three or more transformers at a single location will ordinarily mean excessive secondary copper costs and poor voltage regulation in the secondary distribution. The modern, economical method of distributing power to low-voltage load is by means of unit substations ranging in size from 600 kva to 1200

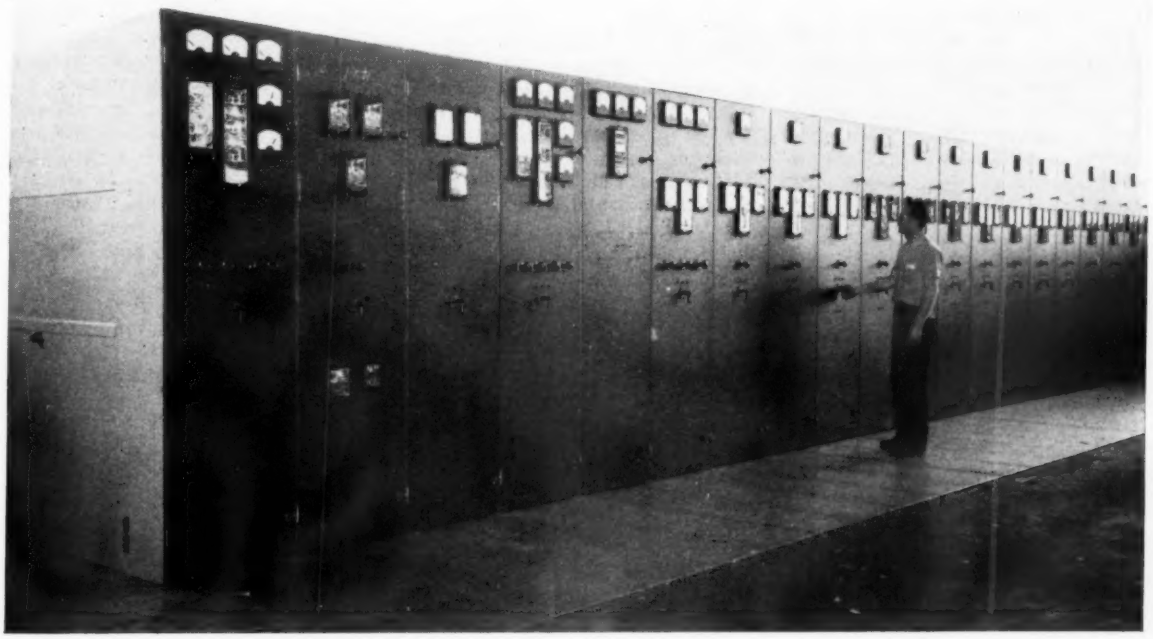


Fig. 3. Metal-clad switchgear for typical industrial plant. (2300-volt circuits.)

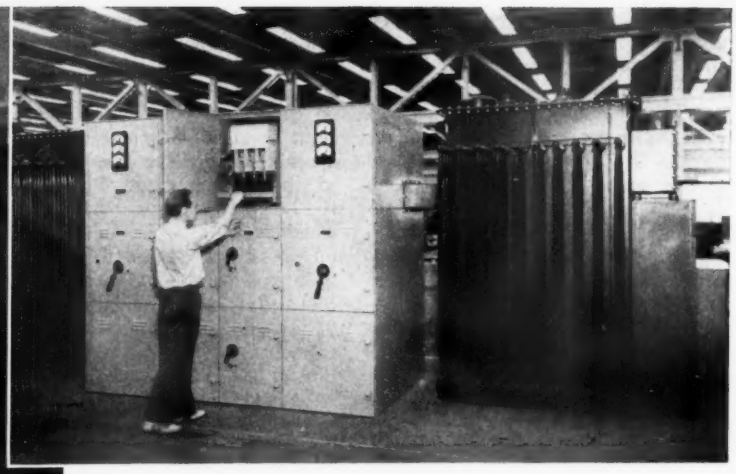


Fig. 4. (Left) Vertical lift, oil-less power circuit breaker being placed in position in metal-clad switchboard.

Fig. 5. (Above) Load-center unit substation with draw-out type circuit breakers.

kva for 480-volt service with single or double units located near the load centers.

In an existing installation, one useful means of reducing feeder short-circuit current, and consequently the cost of motor branch-circuit protective equipment, is a current-limiting reactor in the feeder, as shown in feeder (a) of Fig. 1. For given circuit conditions, there will be practical limits to the obtainable reduction in short-circuit current and in the amount of load that can be economically fed from a single feeder. These limitations are not so restrictive, however, that they prevent regarding feeder-reactors as useful system adjuncts.

A wise selection of system voltage assists in avoiding concessions in desirable system characteristics. Higher system voltage for the same capacity of course means lower short-circuit currents, and this in turn will tend to reduce the cost of circuit protective equipment. Unfortunately, there are voltage limitations to be observed in the interest of serviceability and costs of rotating machinery and motor controllers; so system voltage can by no means be regarded as a completely flexible item for reducing short-circuit current levels.

The following review of some typical circuit protective equipment places particular emphasis on improvements and advances in the art that have taken place over the past few years.

Modern oil circuit breakers for high-voltage circuits are smaller in size, require less maintenance, and display superior interrupting performance by virtue of improved principles of arc interruption. They are available in metal-clad construction in which a vertical-lift and easily removable breaker with all necessary circuit accessories is completely housed in a metal enclosure for safety. These units are available singly or can be lined up as shown in Fig. 3 in a row with a continuous insulated bus.

More of an innovation is the availability of oil-less circuit breakers in a similar physical arrangement. Fig. 4 illustrates one of these newer breakers of the vertical-lift type. The complete elimination of oil is an achievement in the safety aspect of power circuit breakers that is receiving increasingly wide recognition.

Modern power circuit breakers are inherently faster than older breakers; and their ability to clear faults quickly and with precise coordination has been greatly improved through the availability of faster, more accurate, and more reliable relays. Relays are now available in the draw-out type, a very important improvement which allows replacement of a relay for continued circuit protection while the one removed is being checked.

Oil circuit breakers have generally disappeared from low-voltage feeder circuits. The modern device is a compact, less expensive, more serviceable, fast-interrupting air circuit breaker with built-in trips. These breakers are available in draw-out construction in metal-enclosed equipments providing the same advantages as the high-voltage breaker equipments. A typical equipment employing manual breakers is shown in Fig. 5.

The recently introduced practice of "cascading" allows the use of properly coordinated air circuit breakers at considerably less expense in many common circuit arrangements. Fig. 6-a illustrates a practical cascade connection of air circuit breakers in the 480-volt secondary of a radial-feed 1000-kva unit substation. The cost of the secondary switchgear is 18 per cent lower than for the usual arrangement of breakers shown in Fig. 6-b for the same number and rating of feeder circuits.

These air circuit breakers are used not only in the main feeders, but they are also used to protect subfeeders and branch circuits. Fig. 7 shows one of these breakers in a unit enclosure suitable for wall mounting at these points in the system. In the smaller ratings for this latter application, the breaker encounters price competition in the very compact thermal-trip type branch-circuit breaker and the fused safety switch.

The modern low-voltage cartridge fuse with plated contacts and perhaps a contact clamping arrange-

ment to overcome contact heating trouble, provides inexpensive and effective short-circuit protection in branch circuits for smaller motors.

Some of the most difficult protection problems are encountered in 2300-volt motor circuits. In many large industrial plants the short-circuit duty in the 2300-volt motor branch-circuits has been permitted to reach dangerously high levels. Here the hazard of complete disruption of some types of motor controllers is the element of greatest danger to personnel in the entire plant. A satisfactory solution to the problem was sometimes obtained through the use of circuit breakers as motor controllers. However, in applications where there was frequent starting duty, breaker maintenance constituted a real handicap. The use of a circuit breaker of adequate interrupting rating to back up a contactor-type controller suitable for frequent starting duty was not a solution to the problem of safety. The time required by the breaker to interrupt, though relatively short, was far too long to prevent serious damage to or destruction of the contactor.

On the other hand, high voltage fuses with half-cycle operation have been suitable for protecting contactor-type motor controllers against short circuits up to about 10,000 amperes. Fig. 8 shows a set of three enclosed oil-fuse cutouts of a type that has been available in providing safe and inexpensive protection for apparatus circuits.

Very recently a new type of fuse has permitted a most useful extension of safe protection to include motor circuits with short-circuit duties as high as 150,000 kva at 2300 volts. Fig. 9 illustrates a completely metal-enclosed, contactor-type motor controller including disconnecting-type current-limiting fuses of the high-capacity class.

This type of fuse is specifically designed for fast melting, followed by quick interruption. Under high short-circuit conditions, the fuse permits only a small fraction of the maximum available current to be reached in the circuit. When the fuse melts, the current is immediately reduced and interrupted all within about one-half cycle. The interrupting action is shown graphically in Fig. 10 with current values reproduced from actual oscillograms.

The obvious benefits of this type of protection for a contactor-type motor controller are that the mechanical effects of high instantaneous currents are virtually eliminated, and the amount of energy released in the contactor by arcing is kept so low that no disruptive forces result.

There is still another very practical advantage of the fast operation of this unique fuse. In common with all circuit protective equipment, it cannot anticipate or prevent circuit faults from occurring; but it limits both current and energy to such unusually low values that the resulting damage is easily repaired. In fact, experience has demonstrated that consequential damage in the case of motor faults has been so slight that it has been actually difficult to locate the point of failure.

There are other devices, lightning arresters for example, that

(*Continued on page 62*)

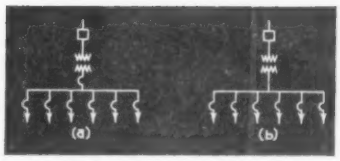


Fig. 6. One-line diagrams of cascade and alternative arrangements of air circuit breakers.

Fig. 7. Manually operated low voltage air circuit breaker.

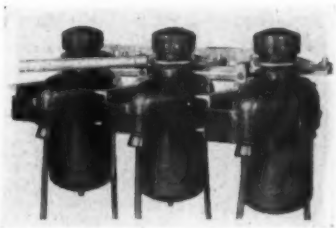


Fig. 8. Pole-type oil fuse cut-outs for simultaneous operation.

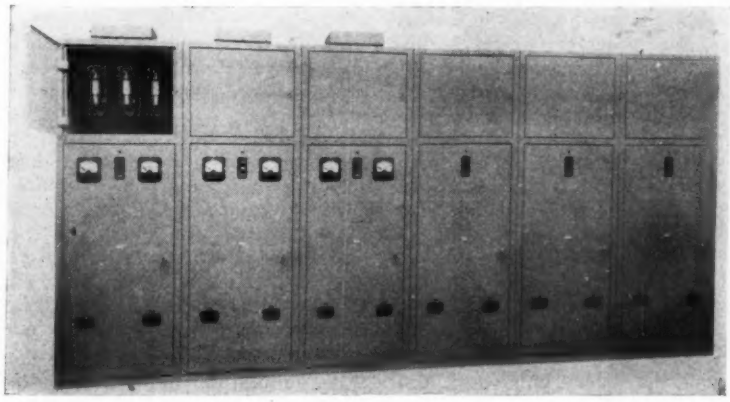


Fig. 9. Completely metal-enclosed 2300-volt motor controllers with disconnecting type current-limiting fuses.

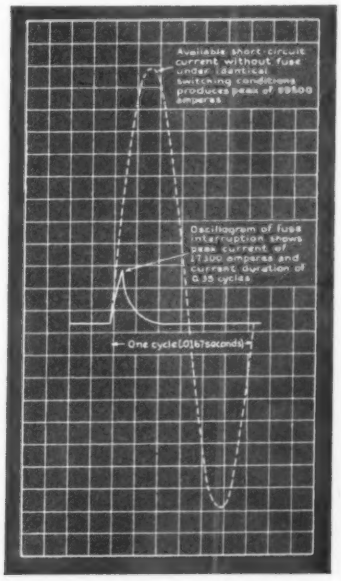

Available short-circuit current without fuse under identical switching conditions produces peak of 89500 amperes
Oscillogram of fuse interruption shows peak current of 17300 amperes and current duration of 0.35 cycles
One cycle (0.167 seconds)

Fig. 10. Performance of high capacity current limiting fuse.

Power Factor Correction Releases Plant Capacity

By R. E. Marbury*

THE TERM "power factor" is used a great deal nowadays in connection with the operation of industrial plants. Practically all plant engineers know that power factor is merely the way of expressing the ratio of power current to the total current in the circuit. It is also generally understood that low lagging power factor can be raised by the use of capacitors. When it comes to applying the capacitors or determining their size, rating, and location, questions arise, many of which are not easily answered except by careful analysis, and an understanding of what is going on in the circuit.

It is natural that power factors should be low in most plants. Many types of machines are hard to start. When a motor is selected large enough for good starting, this same motor is likely to run at light load thereafter. When a 10-horsepower, 6-pole induction motor is operated with a 5-horsepower load, the reactive kva drops only 26 per cent and the reactive kva will increase from .49 to .73 per horsepower.

The working cycle of many machines is such that the motor is operating at full load for only a fraction of the time that it is running.

Often entire plants operate at light load on the motors for a considerable period due to seasonal conditions, and variations in the flow of material or parts.

It must be recognized that the reactive current drawn by induction motors is made up of two parts, one being the actual magnetizing kva which remains substantially constant regardless of load and the other being the leakage reactance kva which varies with load. Since the magnetizing kva is predominant and motors are seldom operated fully loaded, it is obvious that under these practical conditions prevailing in most plants, the induction motor load will have relatively low lagging power factor.

Another cause of low power factor is devices which involve a magnetic field such as transformers, a-c welders, induction furnaces, and the like. Power transformers draw a relatively small magnetizing kva and become important as causes of low power factor only under certain conditions. A-c welders are in effect transformers of a special type, and can be divided into two general types, those for arc welding and those for resistance welding. Arc welders employ either built-in or external reactance in their principle of operation and therefore have relatively low power factor. Resistance welders involve extremely low voltages in the secondary and very large currents. A small unavoidable reactance in these secondary circuits up to the point of weld gives rise to very low power factor.

Induction furnaces of the type where the molten metal forms a short circuited turn on the iron core, have low power factor because it is difficult to build such a transformer with low reactance due to structural limitations.

Other devices may have low power factor for reasons similar to those described. It must be recognized that much effort has been spent to improve the power factor of motors and machines of all types, so that very little further can be accomplished in the immediate future. The best solution to these power factor problems is to correct the power factor at or near the source. Capacitors offer a very popular and convenient method of accomplishing this.

It has been stated that power factor is the ratio of power current to total current, or kw to total kva. There is another factor which is also very important, and that is the time factor. Time is important in many operations today. A certain thing may be worth a great deal more at one time than at another.

Radio broadcasting time varies in value over a wide range with time. Utilities are concerned with power factor because low power factor means higher currents for the same loads. These higher currents do not mean a great deal other than losses they cause, until the currents begin to reach certain limits. The limit may be the size of the wire itself and the heating. More often the limit is the heating of the transformers and generators and other parts of the system whose capacity is measured in current limits or kva rather than real kilowatts.

Utilities are also concerned with time. The time when the power factor is low is very important because only when peak loads are being handled are limits reached. Merely correcting power factor is therefore not enough —correcting it at the right time is also important. Often voltage drop determines how much load can be handled over a given line, especially when the loads are tapped off in many places. A customer who demands a large amount of magnetizing current from the central station is interfering directly with good service to other customers. Magnetizing current causes high voltage drop along the line, complicating the problem of serving regulated voltage to all customers on the line.

Again, the time factor enters the picture. Power factor correction equipment should be operated at the time it is needed. It is not enough simply to operate a capacitor so many hours a month so as to build up a total of reactive kva hours to offset the lagging reactive kva hours for the same month. The leading reactive kva hours must be accumulated on the same time scale as the lagging reactive kva hours to really accomplish anything worthwhile.

As pointed out before, low power factor devices draw a large current in proportion to their kilowatt consumption. When such de-

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vices are operated on the system, they cause an excessive voltage drop due to system reactance. Under steady state condition this is bad enough, but when the devices are connected and disconnected, the sudden changes in current cause sharp changes in voltage drop. When these voltage changes exceed 2½ per cent within a short space of time, such as a fraction of a second, a flicker of the lights is noticed not only in the plants where these machines are located but in the nearby plants and residences.

This can be overcome or greatly reduced in some cases by canceling the line reactance by means of a series capacitor inserted at a convenient point in the line. With certain types of inductive loads having fixed reactance, and reasonably fixed resistance, a series capacitor may be used to cancel the reactance of the load itself. Series capacitors are often used with resistance welders for this purpose. This greatly reduces the voltage dips by extending the time over which the initial inrush of magnetizing kva is taken from the line. The wattless or magnetizing kva builds up over a longer period and is constantly offset by the capacitor leading kva thus reducing the demands from the line to values determined by the kw component.

Industrial Plants Benefit

The use of capacitors may help the plant operation in the same manner as the utility because many of the same conditions exist on circuits within a plant. Correcting the power factor near the load reduces the current in the plant circuit and makes it possible to operate more motors without additional wiring, or makes it possible to operate more motors without installing larger transformer banks. Often the voltage is too low preventing the adding of additional motors or preventing proper starting of motors. These conditions can be improved. The costs of low power factor to the plant operator show up in lower plant efficiency, decreased production, upset schedules due to motors slowing down because of low voltage, and higher billings.

Plant operators often express a desire to improve these conditions by the use of capacitors, but before a satisfactory plan can be adopted one must know exactly what is to be accomplished. The plant operations may be satisfactory enough, but the utility circuits may be overburdened with non-revenue-producing current. Loads may have increased to the limit in the district. Raising present plant power factors to near unity may enable the utility to take on more loads, consequently rates may be set up or existing rates may be enforced making it advantageous to the consumer to correct power factor.

Utility rates may take several forms depending on objectives to be accomplished. The calculation of the capacitor will often depend on the type of rates. This can best be illustrated by the following example of a typical plant load:

Day shift, 7 a. m. to 11:30—12:30 to 5 p. m., 6 days.

Night shift, 6 p. m. to 10 p. m.—5 days.

Day load average, 1,000 kw, 75%

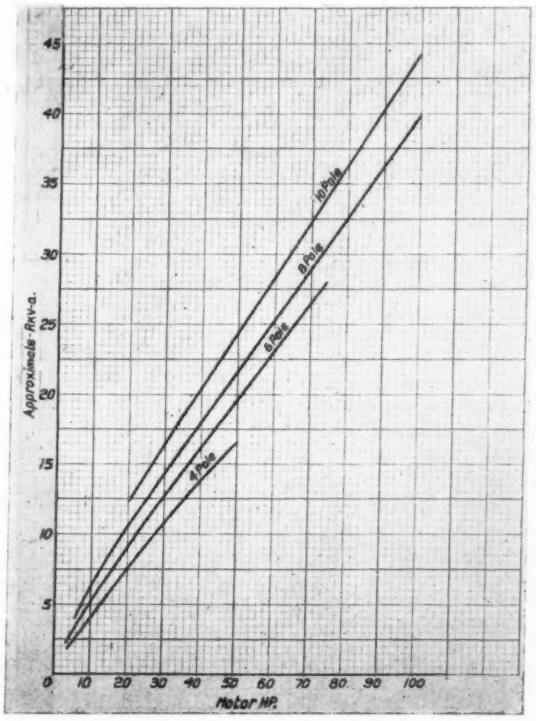


Fig. 1. (Above) Average reactive kva values of typical squirrel cage induction motors at ¾ load.

Fig. 2. This installation of 157 kva in capacitors located at distribution points in a stoker plant reduced power bill and released feeder capacity.

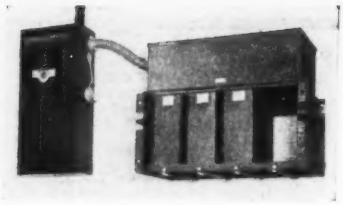


Fig. 3. Typical installation of capacitors located on individual motor circuits.

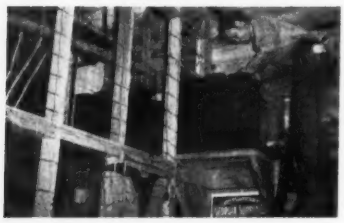


Fig. 4. Dust tight capacitors installed in a wood product plant. 197 kva made up of 7½ kva units, rated at 230 volts, located at the terminals of motors reduced power cost $2,000 annually.

Fig. 5. Mounted beneath the floor of the weave room in a textile plant, these capacitors raised the power factor from 70 to 87 per cent, reducing power costs, improving voltage, and releasing feeder capacity.

power factor, peak 1,500 kw, 85% power factor.

Night load, 300 kw, 65% power factor.

Average load other times, 100 kw, 65% power factor.

Transformer bank, 2,000 kva.

Service 2,400 volts, 3-phase, 60-cycle primary; 460-volt secondary.

Load: induction motors, one resistance welder, one flash welder, and one a-c arc welder.

Let us first assume that an examination of the power rates shows that the kva demand must be reduced.

Kw peak = 1500
PF = 85%
Kva demand = 1770

It is desirable to consider whether it is permissible to overcorrect during light loads. If so, or if the capacitor will be automatically or manually disconnected when not needed, the demand kva may be reduced to 1500 as follows:

$$\text{Reactive kva} = \sqrt{1770^2 - 1500^2} = 940$$

A 940 kva capacitor will supply the necessary correction to reduce the kva demand to a minimum. This may be left on continuously if it does not produce too high a voltage rise during light loads. This can be determined by further calculations which can be made readily by the power salesman. If the correction is too great during light loads it may be automatically disconnected by an electrically operated breaker and voltage responsive control.

The power rates may show instead that it is more desirable to correct the average day load power factor to some value such as 95%, in which case the calculation would be as follows:

Average load: 1000 kw, PF 75%
Kva = 1000/.75 = 1332
Present reactive kva
$= \sqrt{1340^2 - 1000^2}$
$= 890$
Kva at 95% PF = 1000/.95
$= 1052$
Reactive kva at 95% PF
$= \sqrt{1052^2 - 1000^2}$
$= 325$
Capacitor kva required
$= 890 - 325 = 565$

In either of the above cases the best location for the capacitor is on the low side of the transformer bank because this relieves the bank of transformers from handling the reactive kva. However, if the voltage on the low side is 230, the capacitor will cost a great deal more per kva, because 230 volt capacitors are more expensive to build. They require much thinner and more expensive insulation, more foil, more winding labor, and the actual insulation cannot be worked as efficiently as in 460 and 575 volt capacitors.

In considering whether to place the capacitor on the 230-volt side, several factors must be evaluated:

(1) The value of releasing transformer capacity.

(2) The need for immediate release of transformer capacity.

(3) The additional gains that can be made by placing the capacitors out on the plant circuits getting the benefit of released plant circuit capacity and improving the voltage drop near the loads.

(4) Added cost of breakers for the capacitors when placed on the incoming line.

Where these valuations do not net an attractive figure and do not warrant the added cost of 230 volt capacitors, then the best solution is to place the capacitor on the incoming line.

Where the low voltage side is 460 or 575 volts, there should be no point in connecting on the high side. The only question then is whether the capacitor should be placed at one location or scattered throughout the plant. The principal items that favor placing the capacitor out on the plant circuits or individual motors are as follows:

(1) Breakers may cost more for a large bank of capacitors due to interrupting ability required at this point.

(2) Large rack assemblies often cost more since structures are more expensive, involving angle iron and heavy copper bus bars, screens, and sometimes foundations.

(3) Space is not always available for a large bank in the substation, and outdoor banks are more expensive and require runs of conduit.

(4) Capacitors placed direct on motors raise the voltage at the motor terminals, and often do not involve much installation expense, or additional switches.

(5) Capacitors on plant feeders at or near load centers do not require expensive switches as a rule, and relieve these circuits of wattless current.

(6) Capacitors located throughout the plant on motors go off and on as the plant load varies, giving a degree of automatic control.

(7) Capacitors scattered throughout the plant may be located in space not used such as on walls or hung from the ceiling.

(8) Service interruption on a feeder or individual motor capacitor due to fuse operation, or other trouble, do not affect the power factor of the plant appreciably while the same trouble in a single large bank may necessitate shutting down the whole bank a sufficient period to affect the billings for the entire month.

There are things to be said also in favor of large group connection installations:

(1) The total investment in correction may be held to a lower figure where there is considerable

uncertainty where the loads will exist within the plant, on what circuits the loads will occur, and which motors will be running at any particular period. Low diversity factors favors group connection.

(2) An attendant may be already available who can put the capacitors in or out of service as needed, or automatic control may be installed to connect and disconnect the capacitor according to voltage, current or reactive kva.

(3) If the plant has high ambient temperatures, acid fumes, or other conditions, a group capacitor in the substation may be the best solution. This is certainly to be preferred to purchasing capacitors designed to operate at higher than standard ambient temperatures because the latter are considerably more expensive.

Many utility rates are such that the power factor must be considered on an integrated basis, over the month, and the power factor in this case is determined from the cumulative kilowatt-hours and reactive-kva-hours, as recorded by appropriate meters.

Let us assume that the total kilowatt-hours for the month is 283,400 and the total reactive-kva-hours is 272,158, as determined from reactive-kva meters and kilowatt-hour meters.

Assume further that it will be worthwhile to cancel most of the reactive-kva-hours for the month giving a monthly power factor of 90%. Where such rates are in effect, the meters used usually are designed so that capacitor kva in excess of that required to correct the power factor to unity at any time, is of no advantage. In other words, the capacitor cannot cause the reactive-kva-hour meter to run backwards. This is another place where the time factor is taken into account.

The utility rate gives the customer the benefit of using a capacitor only when that same customer should be operating a capacitor, and in addition takes into account the amount of correction necessary at the time. In a case like this, it would be easy to simply make the capacitor large enough to correct the day load power factor to some value such as 90% and leave it on throughout the month merely making sure the capacitor is large enough. However, if one is interested in determining the smallest capacitor that will do the job, a systematic approach is required, and often will be found very profitable. In this analysis time is the all important factor.

In applying capacitors for the purpose of building up leading reactive-kva-hours for the month to affect cumulative lagging reactive-kva-hours, it is well to keep in mind that a small capacitor effective throughout the entire month can build up a substantial total of leading reactive-kva-hours. Particular attention therefore should be given to those loads which are on all the time, and which produce reactive-kva-hours 24 hours per day, seven days per week, such as transformer magnetizing kva, blowers, lighting loads which have poor power factor, and small motors that are always running in some processes.

Examing the load schedule, we find that the load may be divided into three general levels with the average power factor and reactive kva applying to each. This does not have to be done with great precision.

First determine the lowest level below which the load never drops. This is the load during the hours when the plant is not operating such as from 10 p. m. to 7 a. m. and on Sundays and holidays. It is estimated to average 100 kw, 65% PF, in this case.

$$\text{Kva} = 100/.65 = 154$$

$$\text{Reactive kva} = \sqrt{154^2 - 100^2} = 117$$

It is now obvious that a 117-kva capacitor will be effective throughout the entire month, or 730 hours, accumulating 730 x 117 or 85,410 reactive-kva-hours, during which time the power factor will never be leading because all variations in load are equal to, or above, 100 kw.

This is the most important block of capacitor reactive-kva-hours, and in many cases it will be one-half of the total needed to meet the requirements.

Next determine an estimate for the lowest level of load during the night load period. Let us assume that this is 300 kw, 65% PF, and a reactive kva of 351.

It was stated that the day load consisted of nine hours per day six days per week. This may be taken as 216 hours per month. The night load was four hours per night, five nights per week, giving 80 hours per month. 80+216 gives 296 hours during which the load will not drop below the night load level, and 296 hours during which

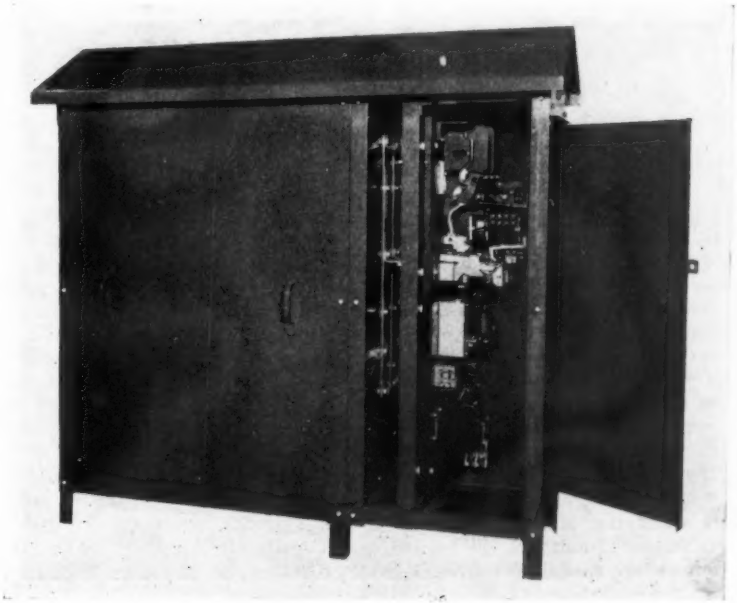


Fig. 6. Outdoor 180 kva, three-phase capacitor with circuit breaker and automatic voltage control, arranged to connect the capacitor to the line at 465 volts and disconnect it at 495 volts, or other predetermined settings within this range. Provisions are incorporated in the control for time delay of 25 seconds or more in the initial response to voltage change. Manual reset must be pushed if breaker trips on overload or short circuit.

the reactive kva will not drop below 351. Since 117 kva of capacitor is already on the line we need 351—117 or 234 kva more.

This 234 kva of capacitor being effective 296 hours per month, will accumulate an additional reactive kva of 234 x 296 = 69,264.

We now have a total of 85,410 + 69,264 or 154,674 capacitor reactive kva hours.

If the integrated kilowatt-hours for the month is 283,400, and we want a monthly PF of 90%, the reactive-kva-hours must be reduced to 137,500, as shown below:

$$\text{Kva-hours} = 283{,}400/.90 = 315{,}000$$

$$\text{Reactive-kva-hours} = \sqrt{315{,}000^2 - 283{,}400^2} = 137{,}500$$

Therefore, 272,158 — 137,500 = 134,658, which must be cancelled by the capacitor kva hours. We have already developed 154,674 which is more than we need. We found that the 117-kva capacitor accumulated 85,410 reactive-kva-hours. Subtracting 85,410 from 134,658 leaves 49,248 to be accumulated during the next highest load level.

This next load level lasts 296 hours. Therefore, 49,248/296=167 kva. This additional capacity will be required. Total size of capacitor is 117+167=284 kva.

The 284-kva capacitor can then be left on the line all the time and the intergrated monthly reactive-kva-hours will be reduced to 137,500, the value required to give 90% PF on a monthly basis.

If a capacitor had been selected which would raise the day load power factor to 90%, a 394-kva capacitor would have been required. This would, in this case, have been about 40% larger than necessary.

Now that we have found that a 284-kva capacitor is sufficient, the next question is where to locate it. Of course, the capacitor should be rounded out to a multiple of 15 kva, such as 285, to line up with standard ratings. Also the entire 285 kva may be operated all month if over-voltages are not encountered during light load. The advantages of locating the capacitor out on the feeder or on individual motors has already been discussed, but should be further considered.

First, we know that 117-kva of the capacity is needed at all times. Locate this, say 120 kva, either at one place or several places on the circuits in the expected manner of load distribution when the plant is idle, connecting it direct to the feeders. If great uncertainty exists as to what feeders will be in use, place it at the main transformer bank or point where the feeders originate.

We now have 165 kva left. A study of the feeders and loads during night load period may reveal that certain pumps, fans, conveyors, etc., are always running when the night load is on. Connect capacitors directly to these motors, being careful not to use an excess capacity on any particular motor. See Figure 1 for approximate size of capacitor.

This arrangement will dispose of the 285 kva of capacitors in a most convenient way. The same general scheme can be followed for other load variations that might prevail in any plant.

Even where over-voltage exists during light load this plan will provide a degree of automatic control that will usually meet the needs.

The actual kva should be chosen to fit manufacturing standards which have been worked out to secure greatest overall economy. A large bank can usually be obtained in values to the nearest 15 kva. Small banks can be obtained in frames consisting of 2, 4, 6, or 8 units assembled together, giving 30, 60, 90, or 120 kva for 460 and 575 volts, and half these values at 230 volts. These can be assembled three high if desired, and are of dust-tight construction.

Figures 2 and 3 show examples of dust tight capacitor installations. They were installed in a plant engaged in the manufacture of domestic stokers. In this plant, the power factor was raised from 70 per cent to 97 per cent releasing needed feeder capacity in addition to producing a saving in power billings of 6 per cent.

For direct connection to small motors 2½, 5, 10, or 15 kva dust-tight capacitors are convenient to use.

Figure 4 is an example of a woodworking plant where individual motor correction was used. Twenty-six 3-phase, 7½ kva, dust-tight capacitors were installed on individual motors increasing the power factor from 66 to 88 per cent and producing a yearly saving of $2,000 with an initial installation of only $3,000. In addition, the voltage regulation was greatly improved.

Figure 5 shows a bank of dust-tight capacitors in a textile mill. Twelve such banks were installed under the floor of the weaving room and connected to feeders supplying one hundred and twenty ½ and ¾ horsepower motors. Similar banks were connected to 1-hp loom motors. The power factor was raised to 87 per cent resulting in a large decreased cost for purchased power. The capacitors used no useful space. Another interesting installation was made in a match manufacturing plant. Power factor was raised from 55 per cent to 75 per cent, reducing the power billings 4 per cent.

It was stated that this plant had a resistance welder. From the standpoint of kilowatt load or integrated power factor this may be of little importance because it is on only for a very small time. The actual weld may last only a few cycles and the total power used may be very small even when the welder is used a great deal. The welder may also have little effect on the kva demand for the same reasons. This welder, however, may be a problem because the sudden reactive-kva peaks may be causing lamp flicker. The utility may demand that it be operated only during certain periods, or at a low tap, or they may set up a special instantaneous demand charge because of the welder.

When these problems exist, it is well to consider a series capacitor. Since the series capacitor must be made to fit the design characteristics of the welder and usually since modifications must be made in the welder itself, it is usually best to refer this matter to the maker of the welder to determine what it will mean to fit it with a series capacitor. It must be kept in mind that a shunt capacitor placed in parallel with such a welder will not eliminate the lamp flicker resulting from the operation of the welder, whether it is floated on the line or switched on and off with the welder.

If a series capacitor is put on a resistance welder for eleminating instantaneous peaks and reducing lamp flicker, it must be noted that this is rather independent of the general problem of power factor correction of the plant load. Such a series capacitor will be in addition to that required for power factor correction since the series capacitor is in use only a small

(Continued on page 60)

Electrical Heat in Industry Offers Many Advantages

By M. M. Greer*

EVEN BEORE the advent of war, industry was geared to mass production through highly modernized methods, in which the application of standard electrical heating units to industrial processes and manufacturing methods was a contributing factor. The ability of electric heating units to generate heat at the right spot and confine the heat to a particular area with accurate temperature control, flexibility of performance, dependability and cleanliness of operation, has rapidly led to the elimination of slow, hazardous and bulky equipment. Now, more than ever, electric heat is taking a foremost part in industry in producing the essentials of war, as well as of modern living, by stepping up production while maintaining low operating costs.

Space does not permit an involved or highly technical discussion. Therefore, this paper will be limited to a number of interesting applications of standard electric heating units to industrial heating methods, such as those found in almost any plant. Perhaps the most frequent application is that of

Contact Heating

The automotive industry was quick to recognize the advantages offered through the use of plastics. Figure 1 shows a close-up view of one of the electrically heated extrusion presses used for molding plastic parts. Note the neat, compact and efficient installation of pre-formed electric strip heaters around the cylinder. Similarly equipped extrusion presses eliminated all external steam pipes, flexible joints, valve and steam traps, resulting in superior working conditions, increased production, and low operating and maintenance costs. Accurate temperature control of electric heat assured uniformity of the product, an essential requirement in this industry.

The importance of good contact between the heating element and the part to be heated cannot be over-emphasized, as heat is best transferred by conduction. Figure 2 shows typical clamping applications of strip and ring heaters to surfaces to be heated, such as pots, kettles, tanks, and so forth. Figure 3 and 3a illustrates the use of cartridge units in platen heating. Drilled holes provide a snug fit with allowable tolerances of .004" to .007" per inch of diameter.

Contact electric heating applications are practically unlimited, as size is not a limiting factor. Figure 4 shows a 1000-gallon process kettle for manufacturing synthetic resin. The kettle is electrically heated to approximately 500°F. by means of strip heaters clamped to the bottom and sides, having a total capacity of 90kw. Terminal connections are clearly shown, together with the insulating jacket, which has been removed.

Each different application, as a rule, must be engineered separately, but the many types of heaters available make it possible to adapt standard electric heaters to almost every job. New equipment can be designed for the most effective and efficient use of electric heaters. Unfortunately, it is usually impossible to re-design existing equipment. It is then that the many and varied types of electric heating units are really appreciated. This is true not only of contact heating but also of

Immersion Heating

A textile manufacturer required accurately controlled heat for use in a swatch-dyeing process. The therostatically controlled portable immersion heater, as shown in Figure 5, proved to be the answer. A perforated monel metal disc was fastened to the coiled heating blades of the immersion heaters. Sample pieces of cloth were laid on the disc for testing the selection of thread. Constant temperatures were maintained by the use of the thermostat, the bulb of which was attached near the top of the heating blades so that it not only controlled the temperature of the solution but also acted as a safety cut-out in the event the solution dropped below the level of the immersion heater blades.

*Mr. Greer is industrial sales manager for Edwin L. Wiegand Company, Pittsburgh, Pa.

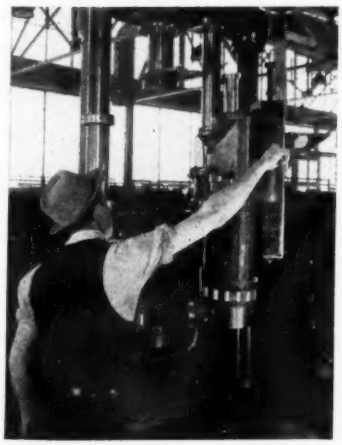


Fig. 1. Close-up view of electrically heated extrusion press used in making plastic parts. Note the neat and efficient installation of pre-formed strip heaters around the cylinder.

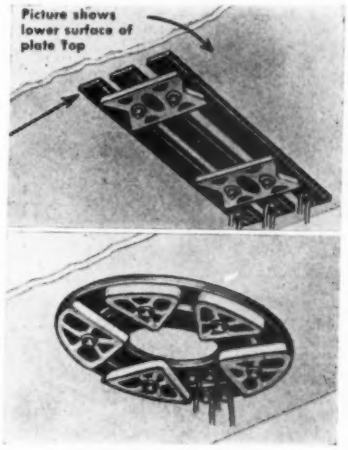


Fig. 2. Method of applying ring units and strip heaters. Note clamping arrangement which insures positive contact and efficient heat transfer.

Fig. 3-a. Electrical heat is utilized in this hydraulic press. Arrows point to units. See 3-b.

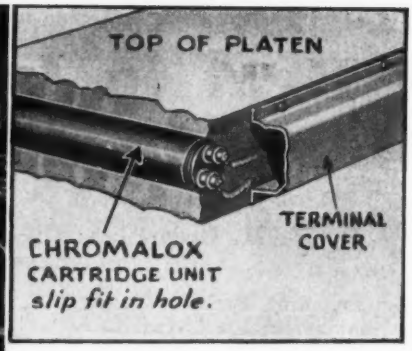
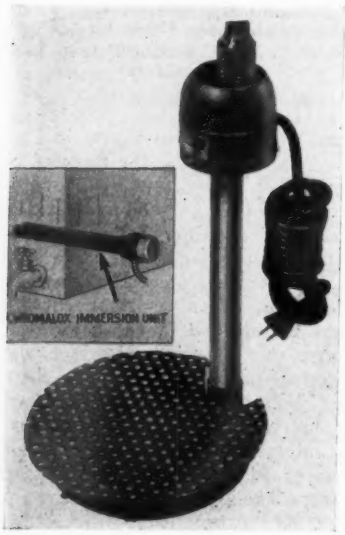


Fig. 3-b. Details of installation of cartridge units inserted in holes in platens of press. Note terminal cover.

Fig. 7. The portable electric heater indicated by arrow liquifies the contents of the drum as it melts its way to the bottom.

Fig. 4. Process kettle showing application of strip heaters. The insulating jacket in the background will be slipped into place to complete the assembly.



Figs. 5 and 6. The large photo shows an immersion heater for swatch dying solution in a textile mill. A thermostat mounted on the heater permits selection of desired operating temperature of dye solution. The small diagram illustrates application of immersion heater assembled in standard pipe threaded screw plug for installing through the wall of a tank. Standard heaters of this type, rated at from 1 to 24 kilowatts are available for heating oil, water and other solutions.

Figure 6 shows a standard immersion heater installed through the wall of a tank using a flange or pipe treaded screw plug. Portable immersion heaters (Fig. 7) have the advantage of generating heat when and where needed and prove invaluable in plants which have a number of drums or tanks which are not necessarily heated at the same time. The illustration shows the application of a standard portable immersion heater for liquifying vegetable shortening in a bakery. The shortening is received in large drums and is solid at ordinary temperatures. In the past it was necessary to cut out chunks and drop them in melted shortening to maintain the proper level. It was difficult to gauge the amount needed when the shortening was added in this manner. By using a portable immersion heater placed on the top of the shortening after the drum had been opened liquid shortening was ladled off in the desired amount as the heat melted its way down into the tank. This simple application effected a saving in material and labor, and as is usually the case, improved operating conditions.

Heaters of this same type are used in melting tar, wax, grease, paraffin, and so forth. Specially rated immersion heaters of similar design are employed for melting lead, solder, babbitt, and stereotype metal, as well as for heating salt and oil tempering baths.

Immersion heaters may also be assembled in a section of pipe with insulated jacket for use as circulation type water heaters and as oil circulation heaters to be connected to fuel oil lines for pre-heating.

Figure 8 shows the application of these circulation heaters to glue cookers. Originally the cookers were heated by steam, but during the summer months it was decided to use electric circulation heaters in order that the main steam boiler could be shut down entirely. This application proved so satisfactory that the use of steam was discontinued entirely. Close control, convenience of operation, and lower operating costs were the determining factors.

Many plants and offices have experienced a similar economy in shutting down their steam boilers during the summer and a portion of the spring and fall months, depending entirely upon the use of electric heaters for

Air Heating

Figure 9 shows an air heater of the natural convection type. The heating elements are standard strip heaters mounted in a protective enclosure of perforated steel, and controlled manually by means of a

three-heat switch. The air discharged from the heater has a relatively high temperature rise, and since circulation is accomplished by natural convection, the heated air is confined to a comparatively small area. These heaters are ideal for small offices, shops, booths, valve houses, and the many hard-to-heat places.

To provide a uniform temperature over a fairly large room, forced convection heaters with motor-driven fans mounted in back of the heating elements are available. (See Figure 10.) These heaters are commonly mounted in such a manner as to direct a continuous circulation of heated air throughout the room. Automatic temperature control is obtained by means of a thermostat.

Where very large heating capacities are needed, finned strip heaters are installed in ducts for heating air under forced circulation. Heater capacities may range up to 100 kw. or more. This type of heater is commony used in air conditioning and heating equipment designed to maintain constant temperature the year 'round.

Oven heaters are a variation of air heating. A certain hosiery mill dried out each stocking after it was knitted and before the foot was sewed on in order to obtain a uniform stitch. (See Fig. 11.) The method used required a drying time of from eight to thirty-six hours, depending upon the weather. This made it impossible to maintain a uniform production schedule. The installation of a fifteen-kilowatt blower-type electric unit heater which circulates 3,000 cubic feet of air per minute made it possible to dry 450 dozen stockings in a period of from two to six hours, independent of weather conditions, thereby cutting the drying time approximately 75 per cent.

The superior advantages of dry heat sterilization by means of an electrically heated oven led a manufacturer, engaged in renovating mattresses, to build an oven such as shown in Figure 12. Both the initial and the operating costs had to be kept to a minimum. The oven was constructed with 2 inches of insulating material between the outer and inner sheet metal walls and was so designed that it was air tight when the door was closed. Heat was provided by twelve strip heaters having a total capacity of 10.8 kilowatts. The strip heaters were mounted in frames at the bottom of the oven. A simple oven thermostat and contactor provide complete temperature control. The total cost was $71. This installation was so successful that twelve concerns in a single city arranged to have similar ovens built.

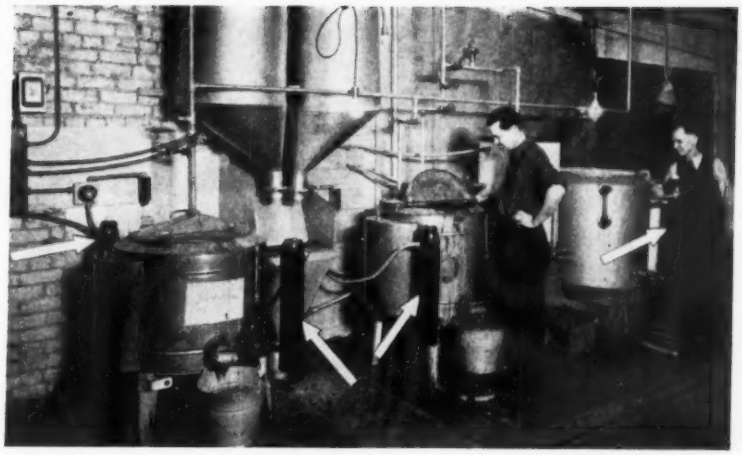


Fig. 8. Lower operating costs, a better product and increased production have resulted from use of electric circulation heaters on these glue cookers. No changes in the steam jacket were necessary.

Standard electric heating units are incorporated in laboratory hot plates, melting pots, branding and soldering irons, and such commercial items as urn heaters, "short order" hot plates, and range plates.

Electric heat is the modern industrial heating method, and progressive plant men are taking advantage of the opportunities afforded by modernizing old equipment or purchasing new electrically heated machinery.

Figs. 9 and 10. Natural convection type air heater (above) and blower type unit heaters have many applications in industry.

Fig. 11. Unit heater in foreground cut drying time by 75% in hosiery mill drying room.

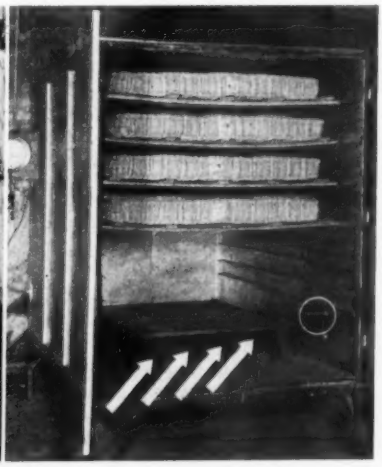


Fig. 12. Strip heaters proved low in cost and operation in this mattress sterilizing oven.

INFRA-RED HEAT LAMP-- A New Tool for Industry

By Paul H. Krupp*

THE NEAR-INFRA-RED process is a new industrial tool which has invariably produced more goods, better goods, in a shorter time, and more economically, too, than heretofore seemed possible.

The ability of the process to boost production where baking, drying, dehydrating and preheating are demanded is comparable to the "brass-tack" approach of Donald M. Nelson to the defense production requirements. He has asked, first, that the Army, Navy, Economic Warfare Board, Civilian Supply Division, etc., tell him what they need—then he will set about to produce it on schedule. Likewise, the answer to various baking, drying, etc., problems have been readily forthcoming when the proper approach has been made to the problem and the process.

However, it is not advisable for industrials who are not acquainted with the process or who have not had previous operating experience to purchase equipment and attempt working out processing problems without first consulting a qualified engineer.

Once the proper production speed is estimated, the tunnel length and conveyor speed figured, proper finishes established if it is a paint job, etc., it will be easy for workmen to operate the process.

Attempting to approach the problem contrary to this suggestion may bring the experimenter close to a solution, yet far enough away to be unsuccessful. Disgust with the process invariably will follow and "rob" the ultimate user of available benefits.

Industrials facing production schedules that seem impossible, where baking, drying, etc., are involved should investigate this process and follow the examples set by many of America's leading industrials in the swing-over to the utilization of radiant energy.

Although speed is the most desirable factor today, it is by no means the only reason why industrials have turned to radiant energy. In many cases they have been forced to adopt the process because of shortage of certain metals. Manufacturers of articles who previously used zinc, aluminum, etc., are now using steel and giving it a protective finishing coat.

Others have selected this new tool because constantly changing production requirements demand flexibility. Still others because of the floor space which the process releases and the quickness in starting and stopping production. (See additional advantages discussed separately.)

Many realize it will be a tool just as valuable for peace-time production as now employed for war production.

At least a hundred or more industrials engaged either directly or indirectly in defense production —many of them located in the South—are relying on radiant energy to assist them in various ways.

Inca Metal Products Company, Birmingham, Ala., are baking paint on metal cabinets, army trunks and miscellaneous small metal products in 8 minutes.

Stockham Pipe Fittings Co., Birmingham, Ala., are baking lacquer finishes on 1½-pound hand grenades and 3-pound bombs at the rate of 500 to 1,000 per hour.

The Only Cage Company, Aberdeen, Md., normally manufacturers of pens and cages, have turned their plant over to the production of steel tables and cabinets for use by armed forces. Baking of paint on this material requires 8½ minutes.

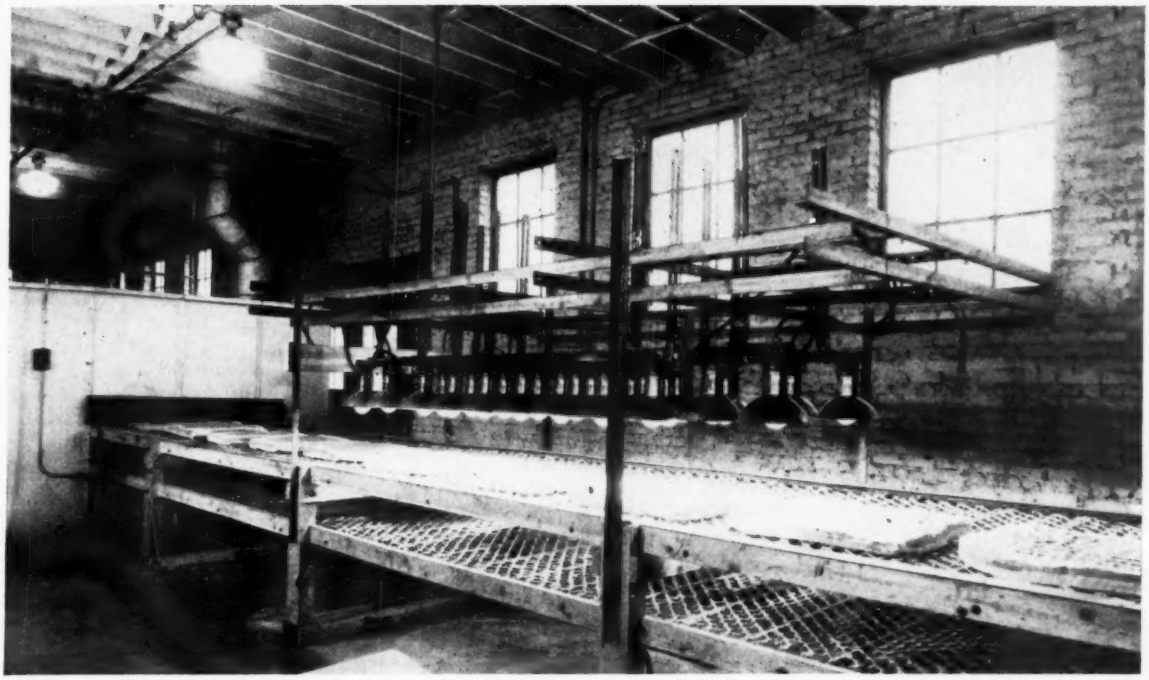
Bona-Allen, Inc., Buford, Ga., uses the process to dry sprayed shoe leather hides in 40 seconds.

Fulton Bag & Cotton Mills, Atlanta, Ga., has a direct defense application: drying latex on the bottom of silk exploder bags,

(*Continued on page 40*)

This bank of infra-red lamps in the Bona-Allen, Inc., plant at Buford, Georgia, dry sprayed shoe leather hides in 40 seconds, as they move forward on a flat conveyor. Another interesting application in a southern plant is shown at top of next page. The Southern Spring Bed Co., of Atlanta, utilized radiant energy from infra-red lamps to dry sprayed latex on auto seat material. Conventional equipment would have cost several times as much and would have required nearly an hour for the drying which infra-red lamps accomplish in 45 seconds.

*Mr. Krupp is associated with Fostoria Pressed Steel Corporation, Fostoria, Ohio.



How the Near-Infra-Red Process Operates

The near-infra-red process at work is fast, economical and flexible. It is nothing more than the utilization of radiant energy, as emitted by the filament lamp. This energy travels through the atmosphere in the form of electromagnetic waves, and when these waves are directed upon some material substance, they are absorbed quickly and are transformed into usable heat. Utilization of this energy requires no physical conductor or relatively high ambient temperatures to act as a convector.

Filament lamps used in the process are called infra-red lamps and are designed to generate a minimum amount of "light" rays—the fewer the better. Filaments may be made of either tungsten or carbon.

Before radiant energy emitted by infra-red lamps can be used to advantage for industrial purposes, it must be collected and reflected efficiently. Thus, the first step in utilization is to house the lamps in properly designed reflectors. Only by so doing is it possible to exercise proper control of energy.

Among the best reflectors are those made of steel—plated with gold—because steel gives the best service in industrial installations, and gold is among the best reflecting mediums for radiant energy. Reflectors designed to accommodate the variety of lamps used regularly in the process and to control easily the distribution of energy are most desirable.

Advantages of the Infra-Red Process

(1) Quicker. No oven preheating is necessary—so the near-infra-red process goes to work immediately the lamps are turned on. Radiant energy is absorbed quickly; drying, baking, dehydrating, and preheating begins rapidly. In many cases, this time-saving is sensational by comparison.

(2) No Stand-By Loss. Since a near-infra-red installation may be turned on and off as needed without sacrificing efficiency, stand-by loss is eliminated.

(3) Visible Operation. Equipment to operate the process is constructed so that every step of the drying operation may be seen readily. This permits continuous inspection and makes unnecessary the use of energy on inferior pieces.

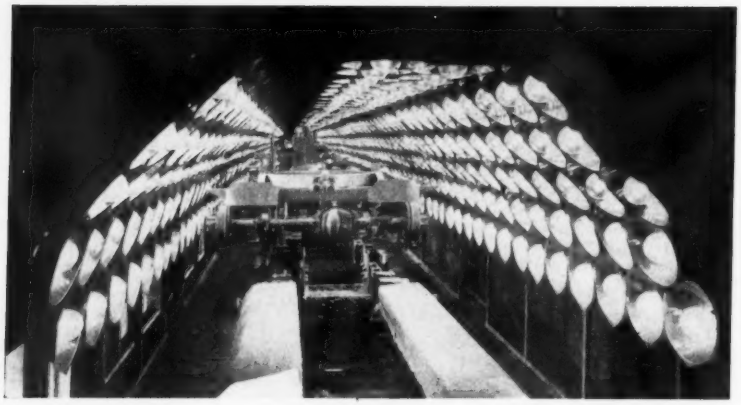
(4) Decreased Spoilage. Uniformly better drying is to be expected when the near-infra-red process is used. All pieces in a production run may be subjected to the same quality, quantity and distribution of energy.

(5) Wider Utility. Equipment to operate the process may be moved easily and adjusted quickly to accommodate a variety of products. The same equipment may be adapted readily to many types of work.

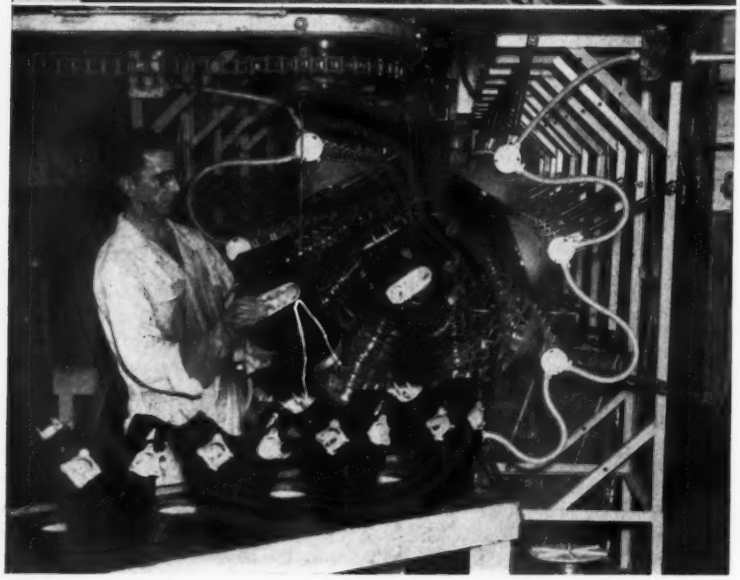
(6) Safer. A near-infra-red installation does not produce hot blasts of air, does not create heavy atmosphere or high temperatures in the surrounding room. It is clean, quiet and safe, so workers are enabled to perform their duties in great comfort.

(7) Takes Up Less Space. Because a little radiant energy goes a long way and does the work rapidly, near infra-red installations take up much less space than other types of drying equipment. In many places, these installations are mounted on the ceiling, thus releasing valuable floor space.

(8) Lower Investment. Initial cost to install the near-infra-red process is lower, as is overall operating and maintenance costs. Once installed, ordinary workmen operate it easily.



Radiant heat lamps are playing an important part in aircraft and other war industries. Above, army "Jeeps" get a prime and finish coat dried in 18 minutes. Center, primer on aluminum sheets is baked on in upwards of 30 seconds, depending upon gauge of metal. Bottom, aircraft engine parts get three composite coats of paint dried in five minutes.



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which are later filled with powder.

When production chiefs can bake 3 composite coats of paint on aircraft engine parts in five minutes and complete further assembly immediately upon coming from the baking zone (Jacobs Aircraft Engine Co., Pottstown, Pa.) there is little doubt the process is a desirable tool and that it has definitely "arrived."

Lockheed Aircraft Corporation, Burbank, California, faced with millions in orders early in 1941 realized that radical changes were necessary in finishing to speed production demands. They installed near-infra-red equipment to bake the zinc chromate primer on alclad aluminum sheets in a baking time of upwards of 30 seconds, depending on the gauge of metal used. The sheets are later formed into the various aircraft parts. In addition to speed-up, the process released much needed floor space. Radiant energy is used similarly by Vultee Aircraft Corp.

The installation of equipment at Lockheed can by no stretch of the imagination be termed a difficult job. Reflectors, six in a row, were mounted to wiring channels. The wiring channels were in turn placed side by side, reflectors faced down, until 48 such strips had been mounted, making a total of 288 reflectors forming a complete canopy under which the flat sheets pass on a conveyor.

No story on near-infra-red, pertaining to defense production, would be complete without a description and illustration of the Willys Overland job at Toledo, Ohio, producers of U. S. Army Scout Cars ("Jeeps").

The Willys Overland organization has found the near infra-red process a most advantageous tool for process finishing. Early in production schedules of this equipment, their engineers realized the necessity for faster paint baking to meet government delivery dates. Equipment, including the framework and reflectors, is installed within an 185 foot steam convection heating zone, now obsolete. The installation will be able to handle passenger car production after the war as capably as it is now handling the scout cars.

The frame and chassis of the "Jeeps" get a prime and finish coat of olive drab lusterless en-

(*Continued on page 58*)

Industrial Wiring Practice

Part 3 — Good voltage regulation is one of the most important factors in the design of an industrial wiring system. Fundamental considerations are discussed here.

By B. Z. Segall

It is hoped that these expositions on industrial wiring applications and installations will, in some measure, assist you in your work. This series is designed to give you *an* answer to your problem. It may give you *the* answer, but it can only assist you in as much as you will let it. The editors will welcome suggestions as to just what topics you would like to have discussed in future articles.

●

THE CURRENT - CARRYING capacity of conductors in these discussions, so far, has been related entirely to the thermal characteristics of the conductor insulations. Another consideration, and most often of greater importance in the designing of wiring systems, is voltage drop. The following tabulation shows how the light output varies for an incandescent lamp of a certain rated voltage for various percentages of decrease in socket voltage applied to the lamp.

Rated Voltage Of Lamp	Socket Voltage In Per Cent of Rated Voltage	Per Cent Light Output
100%	100%	100%
100%	99%	97.2
100%	98%	93.4
100%	97%	90.7
100%	96%	87.0
100%	95%	84.2
100%	90%	69.7

Electric motors as a rule will operate quite successfully at 10% above or below their rated voltage. However, the speed of a motor is dependent, in many cases, on correct voltage and a drop in the potential to the motor may seriously affect its output. As a rule, motors are not as susceptible to normal voltage variations as are lighting loads.

In general, low voltage causes inefficient operation of electrical apparatus and machinery. When evaluated, in dollars and cents, it will be found that in many cases a higher first cost resulting from the use of larger cables, etc., to reduce voltage losses, can in the long run be justified. The greater output and the smaller cost for the copper losses will in all cases prove the economy of some expenditure for the elimination of low voltage.

It should be noted that the code recommends a maximum of 1% feeder drop for lighting installations and 3% for power loads. Designing the system for about 1% additional drop in the service entrance conductors and about 1% or 2% additional drop in the branch circuit wiring to the last outlet on the branch will result in an efficient wiring system .

Voltage drop in a d-c system is dependent entirely on the resistance of the conductors of the system. Thus, a No. 14 wire has a resistance of 2.5 ohms per 1000 feet (at 15° C). If type RH wire is to be used in a conduit system, each wire may be loaded to 22 amperes provided the average room operating temperature will not exceed 30° C and not more than three normally loaded conductors are installed in the system. Suppose this circuit is to feed a 115-volt, 2-hp, d-c motor located about 100 feet away. This motor has a running current of 16.1 amperes and must be fed by a minimum size conductor capable of carrying 25% more than this running current or

1.25 x 16.1 = 20 amperes

The No. 14 Type RH wire can handle this load very easily from a thermal standpoint. However the voltage drop for both lines will be 2 X length of one line X (resistance per 1000 feet/1000 feet) X running current = 2 X 100 X (2.5/1000) X 16.1 = 8.05 volts. The motor, therefore, would be operating at 106.95 volts instead of 115 volts. This 8-volt drop is approximately a 7% drop. The motor would, in all probability, operate satisfactorily but not efficiently.

Assume now a total d-c lighting load which would load this 2-wire No. 14, Type RH, circuit to its full capacity. The voltage drop now would be: 2 X 100 X (2.5/1000) X 22 = 11 volts. The 115-volt d-c lamps would be operating at 104 volts. The light output would be but 71% of rated value. On a 3-wire, 115/230-volt d-c circuit, the load, being balanced between the two hot legs and the neutral, will cause a 5½ volt drop to neutral. This would operate the lamps at 109½ volts and permit 85% of the normal light output; still a low value.

The problem of voltage drop must be solved or checked for every installation. The main point of the solution of this particular problem of No. 14 wiring was to illustrate the impracticability of using this size wire if an efficient wiring system is desired.

The tabulation (p. 42) shows the total circuit feet of No. 14, Type RH, wire that may be extended to

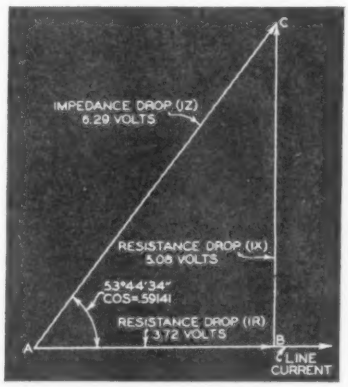


Fig. 5. Relation between impedance drop and its components, the resistance and reactance drops, are illustrated here. The angle of the impedance drop depends upon the ratio of the resistance and the reactance. The resistance drop is always in phase with the line current while the reactance drop is always 90° out of phase with the line current. The specific values of voltage drop given in the diagram refer to the numerical problem described in the accompanying article.

Type of Service	No. 14	No. 12	No. 14 D-C
110 volt, single-phase	19 feet	30 feet	20 feet
120 volt, single-phase	21 feet	33 feet	22 feet
110 volt, three-phase	22 feet	35 feet	—
220 volt, single-phase	38 feet	60 feet	40 feet
208 volt, three-phase	41 feet	65 feet	—
220 volt, three-phase	43 feet	70 feet	—

keep the voltage drop to 2% for a-c circuits loaded to the full capacity of the No. 14 conductor, that is, 22 amperes. For comparison, No. 14 wire on a d-c circuit and No. 12 wire for an a-c circuit is also shown for the same load.

The slight difference in circuit lengths between the No. 14 a-c and d-c systems is due to several factors. In discussing the extension of two or more feeders in separate conduit lines, it was shown that the alternating current flowing in the conductors produces further current retardant effects in addition to that offered by the normal inherent resistance of the wire. The alternating current field set up around the conductor produces within the conductor itself, due to this changing field, a condition known as self inductance. The field furthermore sweeps across the other conductors and produces a secondary inductive effect known as mutual inductance. The combination of both these inductive effects are called "inductive reactance" which offers a definite impedance to current flow in much the same manner as does the resistance of the circuit.

Skin Effect in A-c Circuits

This reactance effect has also a direct bearing on the alternating current resistance value of the cable. The reversing magnetic field tends to increase the current density at the outer periphery of the conductor and actually force the maximum amount of current to flow through the outer layer of the copper conductor. This of course has the same result as passing a certain load through a smaller wire and thus actually increases the resistance of a wire to the flow of a-c current. This is known as "skin effect" and the ratio of the a-c resistance to the d-c resistance is called the "skin effect ratio."

The skin effect ratio increases with the frequency and the temperature at which the cable operates and the size of wire used, i.e., outside diameter of the conductor. The use of tubular or hollow conductors, tends to decrease this ratio. To illustrate these points, assume a 2,000,000 cir mil stranded conductor (outside diameter = 1.631 inches) operating on a 60 cycle system at 65° C. The skin effect ratio is approximately 1.24, or the actual a-c resistance will be 24% higher than the actual d-c resistance. A 300,000 cir mil cable has a ratio of about 1.006. The same 2,000,000 cir mil cable in the form of a tubular conductor having an outside diameter of 2.61 inches and an inner diameter of 2 inches has a ratio of 1.2.

Two cables in close proximity to each other exert a force on each other. The effect of this force is to further distort the current density within the cable so that the maximum current density (greatest current flow) is in the outer edges of the cable peripheries which are nearest each other and taper off to the diametrical opposite sides of the cables that are at the greatest distance apart. This is known as the "proximity effect" and it must be considered in wiring designs especially in the case of bare feeder systems. The force tends to move them apart so that the supports must be designed to hold them securely in place.

The calculation of voltage drop for an a-c system becomes quite complicated and tedious. For the smaller sized cables, the effect of reactance and the skin effect ratio can for all practical purposes be neglected. For example, the resistance per mile of a single conductor of a three-conductor, No. 6 cable operating at 60 cycles and 25° C is 2.21 ohms. The reactance of this cable with 3/64-inch insulation on each cable is but .165 ohms or about 8% of the resistance. A 4/0 cable has a resistance of .275 ohms and a reactance of .135 ohm for the same conditions of operation and construction or approximately a ratio of 2 to 1 instead of 12 to 1 as in the case of the No. 6 cable. A 450,000 cir mil cable has approximately equal values of both, .129 ohms resistance and .128 ohms reactance.

As the insulation thickness is increased for increased voltage operation, the reactance increases so that as the two or three conductors in a cable are separated further apart the effect of the reactance drop becomes of greater importance in designs of smaller wiring systems. Thus the No. 6 cable with 10/64-inch insulation on each conductor has a reactance of .234 ohms per mile or approximately 11% of the resistance value of 2.21 ohms.

Conductor Spacing Important

Where open conductors are installed on insulators this reactance value assumes even greater importance because of the greatly increased distance between conductors. For example, the minimum spacing between conductors for open wiring on insulator installations operating at 300 volts or less is 2½ inches. Assuming No. 4/0, Type RH, insulated wire is to be used, the diameter of each cable will be about 0.78 inches. The minimum distance, center to center of these cables to obtain the 2½-inch spacing must be about 3¼ inches to 4 inches. Assuming a 4" spacing for a single phase, two wire or a symmetrical three wire, three phase feeder, i.e., triangular arrangement to give 4-inch spacing between all three conductors, the reactance now is .376 ohms per mile as compared to the value of .135 ohms reactance and .275 ohms resistance for the same size feeder arranged in a 3-conductor cable with 3/64-inch insulation per conductor.

The design of a-c open wire installations must be carefully executed. The reactance drop value must be definitely determined if the system is to deliver a voltage to its connected equipment that will insure proper and safe operation of the equipment. While Table 2 of the National Electrical Code shows a preferential rating for open wire systems, it may be found that we cannot take full advantage of the greater carrying capacity per conductor. Due to the increased reactance and the higher current, the voltage drop

(Continued on page 56)

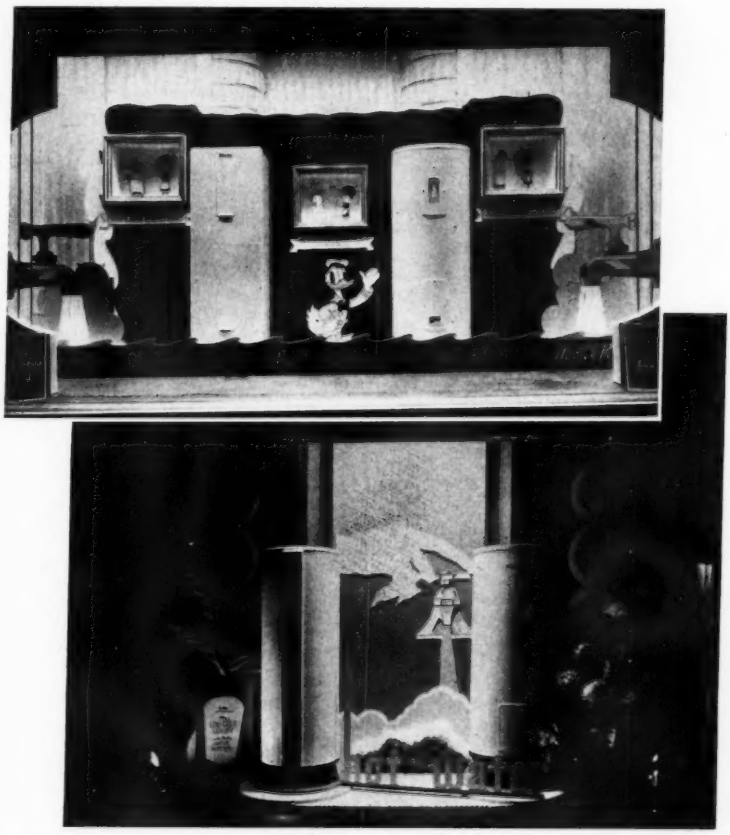
NEWS of the INDUSTRY
National and Southern

Oklahoma Utility Men To Meet March 23

The Oklahoma Utilities Association will hold its twenty-fourth annual convention at the Biltmore Hotel, Oklahoma City, Okla., March 23-24, Among the speakers and their subjects, announced by J. C. Happenny, of Sand Springs, Okla., chairman of the convention committeee, are: "Public Utilities on the Battle Front of Democracy," by E. H. Poe, New York, secretary, Natural Gas Section, A.G.A.; "The State of the Union," by D. I. Johnston, Oklahoma City attorney; "Oklahoma Horizon," by E. J. O'Connor, executive vice-president, Associated Industries of Oklahoma, and "As Others See Us," by Elmer T. Peterson, Oklahoma Publishing Co., Oklahoma City.

W. Lee Woodward, Alva, Okla., president, Oklahoma Utilities Association, will deliver the "President's Address" and Charles T. Evans, Arkansas Power and Light Co., Pine Bluff, Ark., will be the principal speaker at the annual association dinner.

Executives and employees of electric and natural gas utilities, operating in Oklahoma, and surrounding states, will attend the convention. Chairmen of the electric and gas divisions of the association will be elected at the meeting, Miss Kate A. Niblack, secretary, announces. Principal Association officers for 1942 were elected at a meeting in December, 1941.



Southern companies were well represented among the winners in the Modern Kitchen Bureau's water heater window display contest. Shown at top is first prize winning display submitted by Brice L. Pettie, of Gulf States Utilities Company, Beaumont, Texas. Below is the second prize winner submitted by C. B. Osborne, sales manager for Chattanooga Electric Power Board. Included in ten winners of third prize awards was a window display submitted by R. D. Benson, of Georgia Power Company.

Southeastern Electric Exchange Meets in April

The Annual Conference of the Southeastern Electric Exchange will be held at the Edgewater Gulf Hotel, Edgewater Park, Mississippi, on Thursday and Friday, April 16 and 17.

Due to the extraordinary conditions, business meetings will be planned for Thursday morning and afternoon, April 16, with the annual dinner being held that evening; then a business meeting will be held Friday forenoon, April 17, after which the conference will adjourn leaving the afternoon free for relaxation and recreation. An outstanding program on how the industry can cope with present day conditions and geared especially to the nation's war effort is being arranged.

Merchandise Sales Discontinued by CP&L

H. G. Isley, general sales manager of the Carolina Power and Light Company, has announced that for the duration of the present national emergency his company will discontinue the sale of all major electrical appliances so that more of such appliances may be made available for sale by the 300 or more electrical dealers with whom the utility has a co-ordinated sales program in the territory the company serves in North and South Carolina.

Asserting that his company, its allied dealers, its industries, and its customers are facing emergency conditions as a result of the war, Mr. Isley said such necessary materials as copper, steel, nickel, and rubber, are becoming increasingly scarce for the production of appliances.

In addition to discontinuing the sale of major appliances, Mr. Isley

said his company would also stop, during the emergency, the sale and stocking in its salesroom of all seasonable appliances such as fans, room heaters and other appliances. The company, however, will continue to display and sell in its salesrooms such small appliances as are considered indispensable to home operations. Only a limited stock of popular priced floor and table lamps will be carried.

Mr. Isley said the members of the company's sales department would increase their efforts to assist the associated electrical dealers, and added that the company's home economists would redouble their efforts to assist housewives to get the maximum use from appliances they now have.

Also, he added, the dealers will be urged to maintain repair and service departments and to ask their customers to get the very maximum use from all electrical appliances.

Electrical Industry of Carolinas Study Priorities

Approximately 300 members of the electrical industry in North Carolina attended a meeting at Greensboro, N. C., on February 12, sponsored by the North Carolina Association of Electrical Contractors in cooperation with electrical supply houses, wholesalers, manufacturers and electrical inspectors for the purpose of clarifying and coordinating electrical activities in connection with the war production program. The importance of repair and maintenance of electrical equipment was stressed at the meeting.

Speakers included: A. L. Williams, of Washington, D. C., production requirements branch, priorities division of the WPB, who discussed "Production Requirements Plan and Order M-67 Affecting Wholesalers, Sup-

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Washington News Affecting The Electrical Industry

A serious power shortage developing within the present year and growing more acute in 1943 and 1944, is forecast by the Federal Power Commission.

This power shortage, despite all remedial steps which can be taken, probably will make necessary the rationing of energy for residential, commercial and non-defense industrial uses.

These predictions, made by FPC Chairman Leland Olds and Thomas R. Tate, director of the national defense power staff were disclosed by the publication of recent testimony before the House sub-committee on appropriations.

On the basis of the expanded war production programs as outlined by President Roosevelt, Mr. Tate told the committee that the power shortage this year would be around two million kilowatts and next year between three and four million kilowatts. He outlined an eight-point program, including rationing, for meeting the power problem and to assure adequate energy for carrying out the war production program.

Even the war production program planned before Pearl Harbor indicated there would be power deficiencies, Mr. Tate said, but the greatly enlarged program called for by President Roosevelt means that critical shortages in power supply will occur in various sections of the country both this year and next.

* * *

The War Production Board ordered the production of domestic mechanical refrigerators to be discontinued after April 30, 1942, so that the entire industry can be converted into the production of war materials.

Limited production is permitted until the cutoff date. The order issued (L-5-c) supersedes a previous order, L-5-a, which governed the rate of refrigerator production for the months of January and February. The new order permits manufacturers to produce between February 15 and April 30 a number of refrigerators equal to three times the number permitted for February by the superseded order. Thus, a manufacturer who was permitted under L-5-a to build 100 refrigerators in February is permitted under L-5-c to build 300 refrigerators between February 15 and April 30, regardless of the number of refrigerators produced by him during the first half of February under the superseded order.

The War Production Board on February 14th froze manufacturers' stocks of mechanical refrigerators as a preliminary to some form of rationing. In an interpretation supplementing the freezing order, it was stated that retail sales of new domestic refrigerators may be made only from stocks that were on hand at 10 a. m. EWT Saturday, February 14, or that were actually in transit to retailers at that hour.

The order said retailers may sell one-twelfth the number of new refrigerators they sold at retail in 1941 or 100 new refrigerators, whichever is greater, after which their remaining stocks automatically will be frozen.

Under the interpretation, this means that a retailer can make the sales permitted only if he had the stocks on hand or in transit to him at the hour the freeze became effective. If, for example, he had only forty refrigerators on hand or in transit at that time, he cannot obtain an additional sixty from a distributor or manufacturer in order to make 100 sales.

* * *

Domestic washing machines and ironers, output of which has been materially curtailed by Government order, were brought under a price ceiling at the manufacturers' level in Price Schedule No. 86, announced early in February by Leon Henderson, Administrator, Office of Price Administration.

This is the fifth important maximum price schedule issued by OPA in the consumers' durable goods field. Like the others, it is necessitated by reductions in output at Government order to conserve raw materials needed for military purposes. The other lines of consumers' durable goods recently placed under OPA ceilings are domestic cooking and heating stoves, wool floor coverings, radios and automobiles.

While the current OPA order covers washing machines and ironers at the manufacturers' level, Mr. Henderson indicated that his office is prepared to move promptly to prevent any further advances by distributors and dealers.

* * *

Motor rewinding shops, job platers, machine shops, and other shops performing industrial repairs are eligible for priority assistance under the Production Requirements Plan, or the Modified Production Requirements Plan for small business, it has been announced.

By submitting applications on Form PD-25A or PD-25X, according to the size of their business, companies of these types may obtain a priority rating or ratings to be used over a calendar quarter for specified quantities of material. The rating assigned and the quantity of material it may be used to obtain will depend upon the volume of war or essential civilian work being handled.

* * *

The War Production Board on February 25 issued an order, L-6-b, extending to March 15 the February quotas for the manufacture of domestic laundry equipment.

February quotas range from 60 to 95 per cent of the average monthly sales for the 12 months ending June 30, 1941, depending on the size of the plant. Under the extensions, the same rate of production is permitted for the first half of March, the number being half that of the February quotas because it covers only half of March.

Controlled by a . . .

COLT MAGNETIC STARTER

Illustrated is a Colt Magnetic Starter and a Colt Push Button Station.

Designed and built to help maintain today's 24-hour industrial activity . . .

- Straight line vertical operation.
- 3-point ball bearing armature guides.
- Double break pure silver contacts.
- Non-carbonizing molded contact block.
- Thermal overload relays with instant choice of hand or automatic resetting.
- Available in many forms—with local, remote, and transfer switch control.

COLT'S PATENT FIRE ARMS MFG. COMPANY
ELECTRICAL DIVISION HARTFORD, CONN.
106th YEAR OF PRECISION MANUFACTURING

pliers and Dealers"; Dean C. Gallaghar, of Washington, D. C., chief of the maintenance and repair branch of the priorities division, who spoke on "Applications of Order P-100 and Other Assistance Now Available to Electrical Contractors and Industry —the Immediate Outlook," explaining that the order cannot be extended to capital assets, additions or changes increasing the value of any productive equipment; and H. H. Rockwell, priorities specialist of the copper division of WPB, who discussed what copper will be available to electrical distributors.

George D. Wilkinson, of Charlotte, presided over the meeting as chairman.

Kelvinator Ranges Offer New Features

Kelvinator's new 1942 line of electric ranges has been designed to give maximum value to the user in terms of food conservation, economy of operation and the release of more homemaker hours for civilian defense work.

In addition to this timely accent on some of the most important wartime needs of the housewife—which is sharply evident in the leading features such as the Kelvin-Maid, seven-speed surface units and new concealed oven vents—there has been a marked improvement in appearance of the new line, announced recently by Charles T. Lawson, general sales manager, Kelvinator Division, Nash-Kelvinator Corporation.

There are four basic models in the new 1942 series, arranged logically in Kelvinator's step-up fashion, with the buyer moving easily from the lowest-priced model to the highest—from a score of sound, basic features that characterize the entire line to the top electric range feature of the day, the cooking magic of the Kelvin-Maid.

The headline feature of the 1942 Kelvinator electric ranges is the Kelvin-Maid, the new device that starts, times and stops cooking operations automatically. The housewife, now spending more hours in Red Cross work and other new war-time activities, simply places the food in the oven, sets the Kelvin-Maid automatic controls—and goes her way. The meal will be ready at the appointed hour.

Price-leader in the line is the new ER-421, which is priced at $117.95 delivered in the kitchen anywhere East of the Rockies, and has the important basic features common to all of the new Kelvinator ranges.

The body is constructed of rigid one-piece welded steel, with welded internal braces, and one-piece heavy gauge steel cooking platform and back-guard. It has a toe-room base. The finish is of porcelain enamel inside and out, with everything gleaming white except the inside surfaces, back and base, which are black. The cooking platform and back-guard are acid-resisting, and the working surface covers 400 square inches. The capacious utility drawer is on easy-operating roller bearings.

Ring or rod type surface units are available, with non-warping rigid supports. One is an eight-inch, 2000-watt unit; the two others are 6½-inch, 1200-watt units. They are controlled by seven-speed, bi-rotary silver-contact switches with white plastic knobs, mounted on a recessed, incline panel on the range front.

The oven is of the two-unit type, with a 3000-watt top unit and a 2400-watt bottom unit, designed to perform all baking, broiling and roasting operations to perfection. The oven is fully insulated with Fiberglas and the black porcelain enamel lining is of welded, one-piece construction, with rounded corners. A concealed vent assures precise heat and moisture control.

Here are two leading models of Kelvinator's 1942 electric range line—the deluxe, top-of-the-line ER-429, featuring the cooking magic of the new Kelvin-Maid, and (right) the ER-427, next-to-the-top model featuring "built-in" timing equipment. Two other models complete the 1942 line.

Premier Appoints Southern Distributors

R. B. Wilson, executive vice-president and sales manager of the Premier Division, Electric Vacuum Cleaner Co., Inc., Cleveland, Ohio, recently announced the appointment of new distributors of Premier Vacuum Cleaners.

Carolina Sales Corporation, 120 E. Third St., Greenville, North Carolina, is exclusive Premier distributor in that part of North Carolina located east of and including Person, Orange, Chatham, Randolph, Montgomery, Richmond and Anson counties; and that part of the state of South Carolina east of and including Chesterfield, Kershaw, Fairfield, Lexington, Saluda, Orangeburg, Bamberg and Colleton counties.

Williamson, Inc., 228 W. First Street, Charlotte, North Carolina, is exclusive Premier distributor in the portion of North Carolina that is west of and including Caswell, Alamance, Guilford, Davidson, Rowan, Stanly and Union counties; and in the portion of South Carolina which is located west of and including Lancaster, Chester, Union, Newberry, McCormick, Edgefield, Aiken, Barnwell, Allendale, Hampton, and Beaufort counties.

Commonwealth Sales Corporation, 1601 Summit Avenue, Richmond, Virginia, is exclusive Premier distributor in that portion of the state of Virginia which is east of and including Louisa, Goochland, Powhattan, Amelia, Nottoway and Brunswick counties; and south of and including Louisa, Hanover, King William, King and Queen and Middlesex counties.

Chicago Motor Manufacturer Expands Plant Facilities

Small Motors, Inc., Chicago, have moved to new and enlarged offices and factories at 1308 22 Elston Avenue, Chicago, thereby combining all of their facilities under one roof.

Their former offices were 1733 Milwaukee Avenue. They are now combining their two factories and warehouse in one location.

Small Motors have recently introduced to the trade Model "C" of their famous Bantam Motors. This new model has ball bearings and will stand up under heavy usage.

Keep 'em cooking -

WITH

CHROMALOX

THE UNIT THAT FITS ALL RANGES

ELECTRIC RANGE SERVICING MADE EASY

by making unit replacement a one-call job. Carry a few Chromalox units in your service truck, and fit any range that needs a replacement.

ONLY A SMALL STOCK OF UNITS NEEDED

with inexpensive adaptor rings that clip on the unit assembly and fit any opening. No big stock of varied units gathering dust on your shelves and tying up capital. No waiting either, for units that may be hard to get.

ONE CALL SERVICE, GRATIFIED CUSTOMERS

Instead of saying "We'll order the unit you need—it may take a week or so," it's a lot better to say "We'll be over at once, Mrs. Jones, and fix up your range right away." You can do it with Chromalox units—both Super-speed and Heatflo types.

GET SET FOR SERVICE NOW

Keep 'em cooking—replace with Chromalox—the units that cook better and look better—besides being notably easy to clean, economical, and fast.

EDWIN L. WIEGAND COMPANY, 7600 Thomas Blvd., Pittsburgh, Pa.

Write to us or our nearest representative: ATLANTA, Ga.—C. B. Rogers, 1000 Peachtree St.

Westinghouse Briefs

Announcing a NEW Reference Book

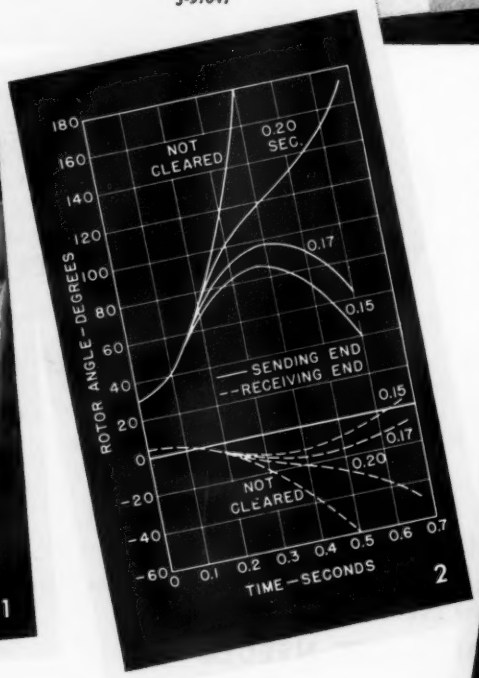
Today, over two decades since the first edition of William Nesbitt's classic book "Electrical Characteristics of Transmission Circuits," transmission line voltages have doubled, lines are longer, interconnections are more extensive and new methods of calculating performance have been adopted. To assist in solving the increasingly complex problems brought about by these changes, Westinghouse has completed a new book, the *"Electrical Transmission and Distribution Reference Book,"* which may be purchased after March 31st. Price, $5.00. Address Westinghouse 3N52, East Pittsburgh, Pa.

WESTINGHOUSE ELECTRIC & MFG. CO., E. PITTSBURGH, PA.

J-97047

NEW AUTHORITATIVE TEXT—In writing the *Electrical Transmission and Distribution Reference Book*, fourteen Westinghouse Central Station Engineers contributed their specialized and practical knowledge. They were aided by other specialists and by co-operative studies with electric power companies. This comprehensive background makes the new text an invaluable aid in solving everyday power transmission problems.

1



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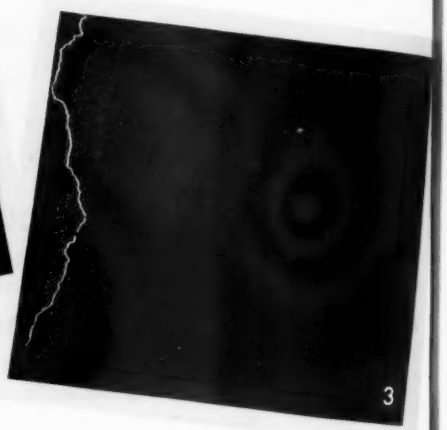
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1 MODERN MACHINES—These four 20,888 kv-a umbrella-type water wheel generators illustrate the typical modern machines discussed in the chapter, "Machine Characteristics." A great number of drawings, formulas, and diagrams are used throughout the book, giving unusual clarity to explanations.

2 CALCULATING STABILITY—The effect of circuit breaker clearing time upon system stability, shown in the figure above, is one of the many calculations covered in the chapter "System Stability—Examples of Calculation." Other chapters deal with every important phase of modern transmission line study.

3 PROVES THEORY—Field station records of this stroke of lightning, photographed as it struck close to a 250 kv line, showed no abnormal voltage. The new book explains how this instance was responsible for establishing protection against direct strokes as the basis for line design.

Westinghouse

"Product Promotion" Given Appliance Service

Profitable dealer service of electric appliances is a "product" upon which war has not placed limitations. This fact has been the principal guide in formulating the 1942 service program of the Westinghouse merchandising division, Mansfield, Ohio, according to L. K. Baxter, service manager.

Good service is regarded as an essential stock-in-trade for appliance dealers. Especially now, service may be the life-saver for many dealers, with curtailments on the production and sale of new products. Service kept some dealers in business in the last war, the same will be true during this war.

Westinghouse has planned its 1942 service program with a definite "product" slant. Service is treated as an activity which a dealer may freely merchandise and sell, giving free play to his own ingenuity and energy.

Chief dealer-helps in the 1942 Westinghouse service program are:

Full Local Promotion Campaign—including store displays, suggested direct-mail solicitation of service business and consumer literature.

Identification — including special service signs for dealer stores, decalcomania panels.

The Service Beacon — illustrated magazine written and edited for dealer employes engaged in servicing appliances; goes out periodically to every Westinghouse service man.

New Sound-Slide Film—"Can You Make It Better," portraying the need for precise service habits—in receiving calls for service from appliance users, in answering calls, in the conduct of service calls in customers' homes. The film is being shown to Westinghouse service men throughout the country.

Schools for Dealers and service men, conducted by Westinghouse service supervisors and distributors' service supervisors.

Pocket-Size "Quick-Check Guide" for service men, a handy reference of procedure in examining appliances to ascertain the cause of complaint.

Qualified Service Men's Club, an organization of service men to focus their attention on the importance of conscientious service efforts to themselves and their firms.

In this program, Westinghouse has outlined full specifications of what seems to be the one thing which dealers can sell to the limit of their service facilities. These specifications are backed with promotional material, an identification program, advertising and training and educational efforts. Headquarters and field organizations have been expanded to help dealers accomplish real strides in the service business.

DISPLAY ARRANGED FOR SELLING—Although the Electric Appliance and Service Co., of Columbia, S. C., expects to feature its service department in the coming year, it certainly hasn't relegated its appliance sales department to the "back room" as this photo of the firm's new display room plainly shows. The well arranged display includes complete lines of major appliances and an attractive center display of small appliances and lamps. M. S. Colvin, who has been connected with the firm in various capacities during the past seven years is now manager.

Victory Spirit Shown By Wire Companies

Another example of American productive ingenuity—and also of the way business is cooperating in our national drive for war production—was revealed by the recent action of the Aluminum Company of America and the Anaconda Wire & Cable Company.

Following the Pearl Harbor attack and the declaration of war upon the Axis, the Aluminum Company was faced with the immediate diversion of the major part of its aluminum production to the manufacture of planes. This resulted, among other things, in some idle cabling machinery designed to manufacture electrical wire and cable.

At the same time, Anaconda Wire & Cable Company found its facilities pushed to the utmost to supply the increased war demand for electrical wires and cables of copper—especially cabling machinery.

Seeing an opportunity to relieve this bottle-neck, Harold V. Engh, executive vice-president of the Anaconda concern, called R. R. Stevenson, general superintendent of the Aluminum Company — competitive interests were shelved for the duration—and in the shortest possible time, this cabling machinery was turned over to Anaconda Wire & Cable Company for a figure substantially under its original cost.

Material Conservation Aids Victory Effort

Ingenious use of new materials in place of critical metals such as aluminum, nickel and chrome has enabled Landers, Frary & Clark, Connecticut manufacturers of Universal Clean Air Cleaners to carry on production of their tank type cleaner within the limits of the Victory Program. Early recognizing the needs of government in its all-out war effort this company decided to eliminate such essential war materials as aluminum, chrome and nickel used in manufacturing its vacuum cleaner and followed out its program to the extent that today none of these war materials is used in its production.

In accomplishing this production "miracle," the manufacturers report that the new Universal Cleaners have lost none of their efficiency and are more beautiful in appearance than ever before.

The engineering problem involved in developing satisfactory new materials for aluminum, chrome and nickel required additional research to find types of materials that would

meet Universal performance standards. In each cleaner built during the early part of 1941, .337 pounds of aluminum, .05 pounds of chrome, and .03 pounds of nickel was used.

During 1941 new materials were found, tested and those that met performance standards were quickly put into production. By the close of the year the changeovers had been completely accomplished.

Approximately 500,000 pounds of aluminum is conserved by the changeover in addition to quantities of chrome and nickel which were formerly used in the plating process to add lustre to the appearance of Clean Air Cleaners.

Norge Announces New Service Plan

A planned service program designed to bring hundreds of thousands of dollars of service business to Norge distributors and dealers during 1942 and to materially aid millions of Norge owners in cutting their utility bills was presented to all Norge distributors this month by J. R. Cameron, service manager for Norge Division, Borg-Warner Corporation. It will be put in effect immediately.

Completely subordinating factory interests to those of the Government's Victory Program and the problems faced today by dealers and distributors alike, the Norge program won immediate and enthusiastic praise from all distributors. Presentation was made to them personally during the recent distributor meetings held in Detroit.

The plan has six major aims: (1) to offset the serious hardships which might be caused by breakdown of appliances now in use which may be irreplaceable for the duration; (2) to maintain user morale through increased efficiency and life of appliances; (3) to conserve electricity by assuring efficient operation; (4) to conserve food supplies by assuring proper functioning of electric refrigerators; (5) to keep the Norge name before the public, assuring maintenance of the potential market at the close of the war; and (6) to add profitable revenue which will offset the lowered gross sales of dealers and distributors.

The program has been thoroughly developed from both the service operations and the service sales angle, and has been checked and rechecked during recent months to assure practicality.

On the operations side of the picture, a careful study has been made of the minimum and maximum equipment requirements for the dealer's or distributor's shop. Tables listing necessary equipment and carefully itemizing costs are provided. Even the dealer whose service experience in the past has been somewhat limited is thus fully informed as to his equipment requirements and may enter the plan with full confidence that he is able to carry it through to completion.

Sales promotion plans are based primarily on the use of a series of cleverly-designed direct mailing pieces. Aimed at arousing immediate interest among appliance owners, the pieces stress the savings which will result from the use of preventive service. Plans have been developed for each Norge product.

The mailing pieces have been so designed and the plan for their use mapped out in such a way that the service sales effort may be controlled to conform to the state of organization of the dealer's or distributor's service department. In this way, the service department which will require expansion to handle eventual full volume may make an immediate start on a smaller scale, defraying overhead and expansion costs meanwhile. Any dealer or distributor now doing any service work at all is in a position to start the plan at once.

PERSONAL NOTES
About Men You Know

C. M. Fife, manager, Electric Home Bureau, West Penn Power Co., is the new chairman of the National Adequate Wiring Bureau's Plan Committee. He succeeds **Herbert Metz** whose appointment as chairman of the Executive Committee was announced recently.

Mr. Fife has been a member of the Plan Committee for more than a year. He has been chiefly concerned with wiring problems during the eighteen years of his association with the West Penn Company and has been in direct charge of wiring promotion since 1930. He also had general responsibility for relations with electrical contractors, inspection authorities, builders, etc.

* * *

Two representatives have been appointed recently by Owens-Corning Fiberglas Corporation to establish sales offices in Richmond, Virginia, and Atlanta, Georgia. Opening of these brings to 12 the number of sales offices maintained by the Corporation, whose headquarters are in Toledo.

A. Randall Hagner has been named sales representative in Richmond.

A. R. Hagner

His office is on the street level of the three-story building at 208 E. Cary Street. His territory includes North Carolina and most of Virginia. Mr. Hagner has been employed by Owens-Corning Fiberglas Corporation since March 5, 1937. For a time he was employed at the firm's research laboratories in Newark, Ohio, as a product engineer in the development of glass textile fibers. He served a tour of duty as acting manager of the Fiberglas branch office in New York City.

Owen Morris

Owen Morris has been named sales representative in Atlanta, Georgia, with an office on the 10th floor of the Norris Building. A native of Nashville, Tennessee, Mr. Morris was graduated as an engineer from Vanderbilt University in 1925. Formerly he operated his own building insulation business in Richmond and prior to that time was district manager of the Philip-Carey Company in Richmond. Mr. Morris' territory includes South Carolina, Georgia, Florida, Mississippi, Alabama, and the Delta section of Louisiana.

W. E. Shafer, formerly assistant to the president of Virginia Electric and Power Co., in Richmond, has been appointed superintendent of distribution for the Suffolk district. **O. V. Sessoms,** formerly superintendent of meters and installations, in Richmond, has succeeded him as assistant to the president.

Mr. Shafer joined the Vepco staff shortly after graduation from V.P.I. in 1928. In 1929 he was made distribution engineer for the Suffolk district, a position he held until 1938 when he became assistant to the president.

Mr. Sessoms joined the organization in 1928 after graduation from V.M.I. and served as distribution engineer and assistant to the general manager of the electrical department until he was made superintendent of meters.

* * *

Top honor in industrial advertising as selected in the annual feature of "Industrial Marketing" goes this year to **Edward L. Andrew,** of Fuller, Smith and Ross, Inc., for the series "Aluminum, Defense and You," written for the Aluminum Company of America.

The award is an annual feature in the "O.K. As Inserted" department conducted for the magazine and the individual selected is described as the "industrial advertising man-of-the-year."

Mr. Andrew, who is a vice-president of the agency, featured in the last year's copy the achievements of the Aluminum Company in the national defense program. Some of the outstanding developments described in the series were: expansion of aluminum production by Alcoa to a rate several times that of 1938, the last full peacetime year; completion of a major portion of the $215,000,000 expansion program which Alcoa financed entirely with its own funds; reduction of the aluminum ingot price to 15 cents a pound, the lowest level of all time, and the company's temporary, but complete, foregoing of civilian markets built up over half a century.

C. C. Carr, advertising director of the Aluminum Company and director of the Association of National Advertisers, was in charge of the series and with members of his department was instrumental in selection of copy themes.

* * *

The Advertising and Sales Promotion Departments which have served the Nash Motors and Kelvinator Divisions have been merged into a single unit of the Corporation, according to an announcement made recently by **F. R. Pierce,** vice-president in charge of sales of the Nash-Kelvinator Corporation.

Personnel of the new department will include **H. G. Little,** Nash advertising director, who previously had many years of experience in the major appliance business, and Kelvinator's advertising director, **C. J. Coward,** who has spent many years in every phase of advertising and merchandising as it relates to durable goods.

The new unit, to be known as the Department of Advertising and Public Relations, Nash-Kelvinator Corporation, will be headed by Little, and Coward will be associate director of advertising.

* * *

Jack Dreyfuss

Jack Dreyfuss, of the firm of Jules J. Dreyfuss & Sons, of Miami, Florida, factory representatives covering the states of Alabama, Georgia, Florida, North Carolina and South Carolina, has been called for service with the armed forces in an anti-tank division at Ft. Benning, Ga. Operations of the firm will be carried on in Jack's absence by J. J. Dreyfuss and his other son, Jerry.

* * *

At a special meeting of the board of directors of the Southwestern Gas and Electric Company, **Frank M. Wilkes** was elected president of the company, succeeding **A. Lieberman,** who died January 16.

N. P. Heath, vice-president and manager of the Shreveport and Caddo parish division, was made executive vice-president, and **Edwin Vennard,** of Kenilworth, Ill., was elected to the board of directors. Mr. Heath will continue his present duties as head of the Caddo and Shreveport divisions.

Mr. Wilkes came to the Southwestern Gas and Electric in January, 1941 as assistant to the president and general manager, and a few months later was made vice president. Previous to his service with the Southwestern Gas and Electric he had been with the Arkansas Power and Light for 22 years, beginning as commercial manager and advancing to vice president and general manager.

Mr. Wilkes was reared and educated in Kentucky, graduating as an electrical engineer from Kentucky State University. His first job was with the General Electric Company, in Chicago. He left G. E. to become district inspector for the Public Service Company of Northern Illinois. After three years, he resigned to become consulting engineer of the Public Service Company of Central Kentucky and soon was made general manager.

He served as a captain in the U. S. A. Signal Corps in the first World War. He served until honorably discharged in September, 1919. Shortly afterward, Wilkes became associated with Harvey Couch and had an outstanding part in the extention of electric service to hundreds of small and large communities, rice and other agricultural sections and the great expansion of the Arkansas Power and Light system.

* * *

All sales, commercial and industrial development activities of Central Power and Light Company, which has its home office at Corpus Christi, Texas, have been combined into one department, headed by **O. W. Jones,** newly appointed as commercial manager, according to **J. L. Bates,** the concern's vice-president and general manager.

The new commercial department includes the work formerly handled by Mr. Jones while head of the commercial and industrial power department, that handled by **Walter E. Dickerson,** as industrial development engineer, and by **H. G. Voigt,** as merchandise manager. Mr. Dickerson recently opened his own office as an industrial engineer in San Antonio, while Mr. Voigt has left the utility company to engage in other activities.

* * *

Ben S. Woodman, formerly of the Roller-Smith Company, is now associated with **Walter V. Gearhart,** manufacturers' representative with headquarters in the Volunteer Building, Atlanta. Mr. Woodman will travel throughout the Southeast,

Ben S. Woodman

representing such well known lines as Duncan Electric Mfg. Co., Roller-Smith Co., Esterline-Angus Co., R. E. Uptegraff Mfg. Co., Struthers-Dunn, Inc., Ideal Electric and Mfg. Co., and Electrical Engineers Equipment Co.

* * *

The Youngstown Steel Products Company has announced the appointment of **F. D. Carroll** as district sales manager of the Dallas district, representing the Youngstown Sheet and Tube Company of Youngstown, Ohio. Mr. Carroll succeeds C. E. Hutchinson, who died in January of this year.

NEW EQUIPMENT and MATERIALS

New Cory Display

A new Cory display for window or counter sets forth in a practical way the merchandise and the special Cory accessories. The colors are cerise, light blue and yellow. Can be used with one model or a full line. An interesting feature is the flexible arrows which tuck into convenient slots and give a third dimensional effect. Four of the Cory accessories are pictured on the display. The

Safety Stand gets further emphasis through the use of the separate display piece which ingeniously fits into one of the actual stands. If the dealer sells only range models, he doesn't use this particular piece relating to the electric stove. Often he substitutes the display card relating to the Cory Glass Filter Rod, which most dealers have.

Silex Victory Model

Silex has just made sensational coffee-maker news by bringing out, in the face of rising costs, a new "Victory" model at the lowest price in Silex history. The new Silex Victory model retails at only $2.45.

The Victory model brings a new style note to glass coffee makers. Both bowls are charmingly figured in a lovely Old Sandwich Glass pattern, in genuine Pyrex brand glass. The result is a new toughness, a new heat-resistant ruggedness, a new distinctive beauty. It is interesting to note that the Victory model was specifically built to effect a substantial saving in metals, an extremely important consideration at this time.

Being a genuine Silex, the Victory model has the time-tested Silex Spring Tension Filter which checks grounds and sediment. The new semi-wide neck facilitates easy cleaning and easy pouring. Complete protection against heat-breakage of the lower bowl is afforded by the Silex guarantee.

Silex has created an intensive series of effective retailer-helps behind the new Victory model. Not only a comprehensive advertising campaign in nationally-important consumer magazines and newspapers, but clever counter-cards in patriotic colors will be furnished, as well as smart new mats and electros.

Proctor 1942 Line

Proctor Electric Company, Philadelphia, has announced a streamlined appliance line for 1942 and a continuation of the company's national advertising program in leading magazines.

The 1942 appliance line will consist of three 1,000-watt iron models: (1) Deluxe Never Lift speed iron with Steamer attachment; combination price $19.90. (2) standard Never Lift; $10.95. (3) Champion, $9.75. Three toaster models: (1) Dual-Automatic, $16.50. (2) Two-slice Pop-Up Automatic, $12.95. (3) Signaling Automatic Turnover, $5.95. All prices quoted include Federal excise tax.

New to the trade among these appliances is the two-slice automatic pop-up toaster, replacing the two-slice automatic which did not have the pop-up feature.

The Never Lift iron will continue to be advertised with ads scheduled every month in both Saturday Evening Post and Good Housekeeping.

Plastic Sweeper Parts

This hand vacuum sweeper nozzle, formerly made of aluminum, is now molded of shatterproof plastic tenite. The part will withstand hard knocks and will clean quickly and thoroughly, even removing lint from mohair, the manufacturer points out. The change from aluminum to tenite not only saves metal vital to the defense program, but due to the non-abrasive surface of the plastic it also minimizes the danger of scratching furniture.

The parts are molded by Zenith Plastics, Inc., Cleveland, Ohio, for the P. A. Geier Co., of the same city,

and assembled on Royal sweepers. Tenite is manufactured by the Tennessee Eastman Corporation, Kingsport, Tenn.

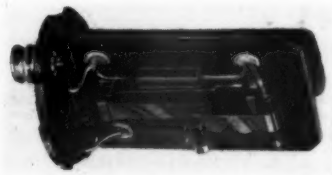
Cleaner-Part Display

A point-of-sale brush display card has been made available to help dealers sell genuine, factory-built Premier brushes to their customers. Actual brushes are attached to this colorful

display card to effectively dramatize the difference between a worn out and a new brush. It reminds the dealers' customers to get a new brush to restore their vacuum cleaner's efficiency.

New Fluorescent Starter

A new line of fluorescent lamp starters, designed to protect ballast and starter and to eliminate the flashing of failed lamps, is announced by Hygrade Sylvania Corporation, Salem, Mass. Called the "Hygrade Premium Mirastat Starters", they are, according to Hygrade engineers, entirely different in principle from any other starters of the kind so far introduced.



Automatically opening the circuit when a lamp fails, the Premium Mirastats are especially suitable for installations that make immediate replacement of a burned-out lamp impractical. Flashing on and off, a lamp that has failed may eventually ruin an ordinary starter. The Premium Mirastat not only protects itself, prevents abuse of the ballast and effects a substantial saving of power, but also does away with the usual annoying flashing of the burned-out lamp. In addition to their special feature, Premium Mirastats contain all the regular features of the popular standard Mirastats. They will supplement the standard line and be slightly higher in price.

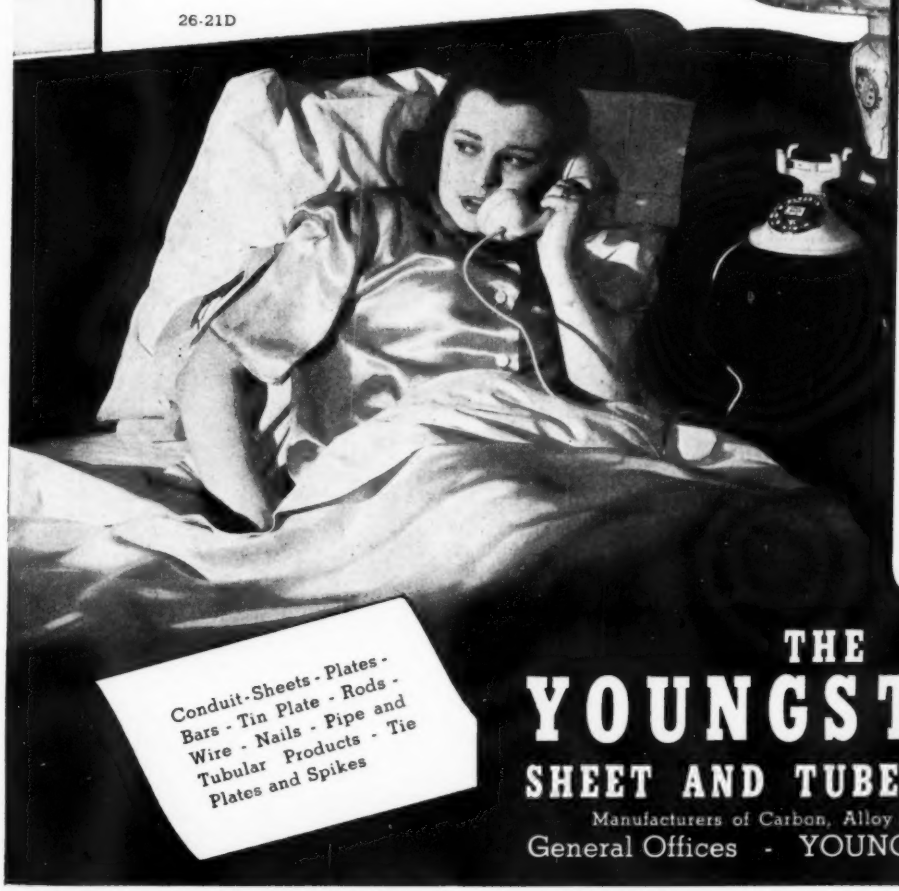
-for Home Defense ★

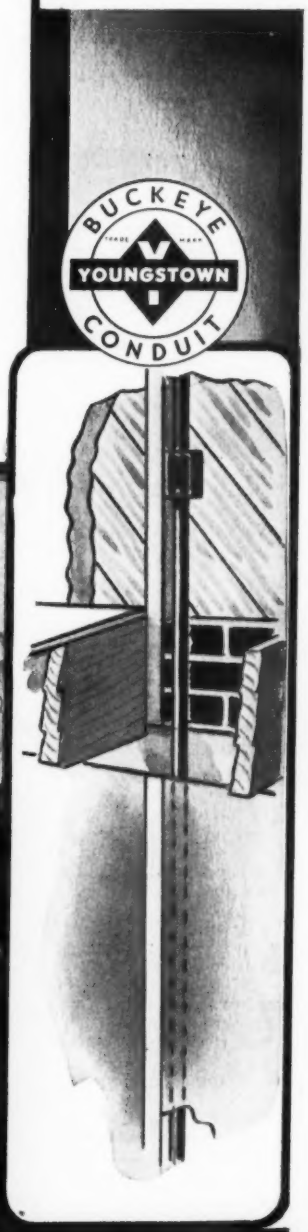
Buckeye steel conduit simplifies installation of extra telephones that guard welfare of the home

To make for better installation of that extra telephone which the owner of the new home is sure to want, remember to put in conduit while the house is being built.

Insulation, firestops, stud bracing or other building materials usually block up spaces in walls and under floors, making it impossible to conceal telephone wires after the house is finished. A few lengths of conduit and outlet boxes, properly located by the foresighted builder, will be worth many times their modest cost, in permitting quick installation of the extra telephone in the kitchen, den, upstairs hall, or bedroom.

26-21D



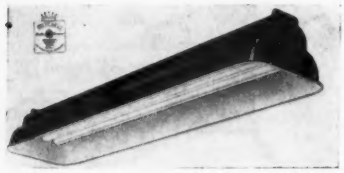


Conduit - Sheets - Plates - Bars - Tin Plate - Rods - Wire - Nails - Pipe and Tubular Products - Tie Plates and Spikes

THE
YOUNGSTOWN
SHEET AND TUBE COMPANY
Manufacturers of Carbon, Alloy and Yoloy Steels
General Offices - YOUNGSTOWN, OHIO

Fluorescent Industrial Unit

The latest Mitchell contribution to industrial lighting for war production is "The Victory," a new fluorescent industrial fixture featuring a porcelain enamel reflector of one-piece, seamless, non-welded construction, made by Mitchell Manufacturing Company, Chicago. It comes in two models—Model No. 2034, using two 40-watt fluorescent bulbs, and Model No. 2035, using three 40-watt bulbs. Both are high intensity, high efficiency units, ideal for high lumen per watt performance. 13½ degree cut-off eliminates glare from all normal viewing angles.



They are made of heavy gauge vitreous steel, with triple-coated vitreous porcelain enamel reflector. Easy to maintain and service because reflector is quickly detachable from the housing. Just remove two wing nuts. Power factor corrected. Latest, approved ballasts and starters. 110-125 volts, a-c, 60 cycle. Also available for 50 cycle operation, or for 220-250 volts. Both units are Fleur-O-Liers and also are listed by Underwriters' Laboratories. Information is obtainable through leading electrical wholesale distributors.

Heating Units and Controls

Electric heating units and controls for industrial application involving the heating of liquids, solids or air are described in a recently revised 38-page catalog announced by Westinghouse Electric and Manufacturing Company.

Specifications, descriptions, ratings and prices of the following types of heaters are covered:

Strip heaters for use in ovens, crane cabs, valve houses, pipe lines, process machinery, hot tables, etc.—maximum sheath temperature of 1200 degrees F.

Finned strip heaters required for forced air ducts, blower units or convection heaters.

Cartridge heaters for spot heating in embossing machines, shoe machinery, cigarette machinery, compounding pots and platen heating—up to 750 degrees F.

Corox water and oil immersion heaters for heating mineral oil, paraffin and alkaline solutions, oil tempering, coffee urns, steam tables, sterilizers, humidifiers, etc.

Air and oven heaters for general heating applications such as crane cabs, truck houses, valve houses, locomotive cabs, scale rooms, garages. etc.

Melting pots for solder, babbitt, paraffin wax and resin—temperature range up to 950 degrees F.

Glue pots with a maintained temperature of from 150 degrees F. to 160 degrees F.

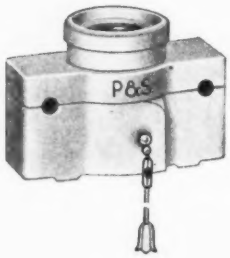
Thermostats, switches, and contactors.

Handy as a reference guide, this booklet contains seven pages of application data and proper selection information in determining the most suitable types and sizes of electric heating units to meet many industrial requirements as they occur. Typical examples of heating problems with the correct solutions are included.

A copy of catalog 28-000 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Porcelain Receptacles

Two types of porcelain two-piece cleat receptacles have been announced by Pass and Seymour, Inc., Syracuse, New York. These units are described in the company's new "Defense" catalog which includes a summary of the P&S wiring device line compiled as a ready reference for the selection of materials for construction, repair and manitenance under the Defense Program.



According to the catalog, the pull-type, Catalog No. 66613, illustrated here, may be used for surface and knob-and-tube wiring as permitted by Construction Quartermaster's Specification No. 8000-E. The pull-type has rectangular base and shadeholder groove. It is rated 250 watts, 250 volts.

A keyless type is also available, its rating being 660 watts, 250 volts.

New RF Lighting Fixture

The new Benjamin "RF" lighting equipment is now available for Victory Production of essential war and civilian materials, according to an announcement by the Benjamin Electric Mfg. Co., Des Plaines, Ill. This new RF equipment, states Benjamin, provides four distinct advances in operating efficiency and economy: it provides even more light for power consumed; it provides a new solution to the flicker problem; quicker, surer starting is assured; and installation and maintenance costs are lowered.

Because of the higher lighting efficiency of the new RF (rectified fluorescent) lamps, and the design and high reflection factor (79%) of the Benjamin Type RF units, it is now practical to employ fluorescent lighting in locations where high mountings or wide spacings of the fixtures are required. With the Twin Lamp RF units, 35 to 40 footcandles of general illumination can be provided with a power consumption of approximately 200 watts when installed on normal 10x10 foot spacings. Due to the lower wattage requirements of these RF units over conventional fluorescent, it is now more frequently possible to obtain the desired higher lighting levels and still utilize the existing wiring.

Lloyd "No-Blink" Starter

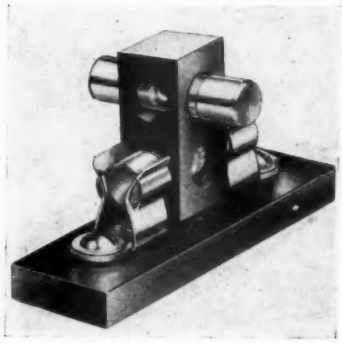
The Lloyd "No-Blink" Starter detects a faulty fluorescent lamp immediately and, after several attempts, if the lamp does not light properly, the starting switch is cut out of the circuit automatically and remains out until the faulty lamp is replaced with a good one. Undue wear and strain on the starting switch and the ballast is thus prevented, and annoyance caused by blinking lamps is eliminated.

The effective lift of Lloyd "No-Blink" Starter exceeds all demands and is several times more than called for by standard specifications. It is listed by Underwriters' Laboratories.

Lloyd "No-Blink" Starter FS-4 NA is designed for use with 40-watt, 48-inch lamps only. It is easily recognized by the green band and owl's head trademark printed on the outer shell.

Fuse-Changing Unit

An entirely new convenience for changing fuses in close quarters—replacing a blown fuse in a twinkling—and giving notice on inspection that another spare is required, are features



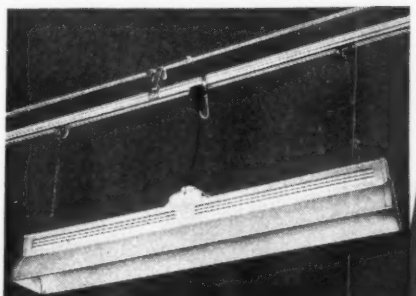
compactly embodied in a Spare Fuse Holder & Puller, combined, just announced by Littelfuse, Incorporated, 4797 Ravenswood Ave., Chicago, Ill.

These new devices are applicable to all 4 AG and 5 AG fuses. The fuse in circuit goes through one end of the soft rubber rectangular Littelfuse Holder, between the clips. Above, and at right angle, is an opening in the Holder for the spare fuse. When inserted, the caps of the spare fuse project beyond the Holder affording an easy grip for two fingers.

When the fuse in circuit blows, all the operator has to do is to pull and reverse the Littelfuse Holder. This puts the spare fuse in circuit and brings the blown fuse on top in the same position that the spare was in before. The change is easily made in a moment.

LOCATE LIGHTS INSTANTLY WHEREVER THEY'RE NEEDED

Parallel runs of BullDog Universal Trol-E-Duct supporting fluorescent fixtures furnish flexible lighting for this aircraft plant which builds trainers for the army and for the civilian training program.



A run of Universal Trol-E-Duct hung from messenger cable, and a typical industrial fluorescent fixture suspended from the Trol-E-Duct itself by weight supports. Current is supplied through the Receptacle Twistout Plug in which a fusible attachment plug is inserted for individual protection of the fixture.

With BullDog Universal Trol-E-Duct

It's no longer necessary to waste precious production time figuring out where lights must be located, or moving old-fashioned wiring to get light at the right spot.

Equip a new plant, or modernize an old one, with BullDog Universal Trol-E-Duct and lights can be located instantly, exactly where they're needed, or moved to new locations in a moment's time.

There are many real savings with BullDog Universal Trol-E-Duct, *for flexible lighting.*

Production time saved, maintenance time lessened, better work because of correct lighting, 100% salvability of the BullDog equipment—these are a few of the money-saving reasons why the busiest industrial plants in the country are turning more and more to BullDog Universal Trol-E-Duct for really adequate, flexible lighting.

Two other time- and money-saving BullDog Bus Duct Systems

The complete BullDog line of "Plug-in" Flexible Electrical Distribution Systems includes two other time and money savers. BullDog BUStribution DUCT, *for power,* takes power right to the individual machines and permits tapping off as simply and easily as "plugging-in" a household electrical device. BullDog Industrial Trol-E-Duct, *for production lines and assembly benches,* furnishes mobile power and support for portable tools.

To learn how to have ready light and power *wherever and whenever needed,* write for complete illustrated bulletins on BullDog "Plug-in" Bus Duct Systems. Better yet, ask for a call from a BullDog Sales Engineer—and ask him to show you the roster of hundreds of armament plants equipped with one, two or all three BullDog Systems.

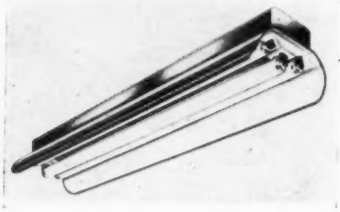
BULLDOG
ELECTRIC PRODUCTS CO.
DETROIT, MICHIGAN
BullDog Electric Products of Canada, Ltd., Toronto, Ontario

MANUFACTURERS OF Fuse-Break Safety Switches, SafeToFuse Panelboards, Circuit Master Breakers, Switchboards, Bus Duct Systems—FOR LIGHT AND POWER

One end of the Littelfuse Holder & Puller is painted red. Until a fuse change is necessary, the red end is underneath, out of sight. When a reverse is made, putting the spare fuse in circuit, the red end is brought into full view on top. To an inspector or service man this red signal instantly indicates that a fuse has blown and that another spare is required.

Fluorescent Industrial Fixture

The new "Three-Forty" Day-Brite Fixture is made to accommodate three 48-inch 40-watt fluorescent lamps. The porcelain enamel reflector is made in one piece, finished in one ground coat and two white coats inside, ground coat and one gray coat outside. Hood of fixture is finished in light gray baked enamel.



"Three-Forty" can be furnished wired or unwired and includes sockets, lamp starters and ballasts. The top of the "Three-Forty" is hinged and can be swung open to make all parts easily accessible for replacement or for making wire connections.

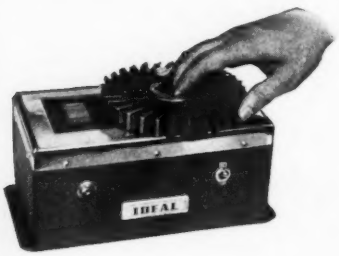
The fixture is available for either chain or pipe suspension, but chain or pipe hangers are not included. Overall dimensions of the fixture are 7¾ inches high, 13½ inches wide, and 52 inches long.

New Demagnetizer

A new, powerful, portable Demagnetizer is announced by the Ideal Commutator Dresser Co., Sycamore, Illinois. It quickly demagnetizes tools, drills, punches, dies, and work held in magnetic chucks. Abrasive particles such as metallic dust, flakes, fine chips, etc., that simply wan't be wiped off clean with a rag are easily removed after a single pass across the magnetic poles.

Large parts may be demagnetized in a similar manner, except that the Demagnetizer, which is light in weight and easy to handle, is moved over the heavy, bulky work.

If tools are not demagnetized, they are bound to attract small and sometimes imperceptible metallic chips and dust. These abrasive particles, that cling to the magnetized cutting edge, rub constantly between the tool and work, causing the tool to bind or heat and dull quickly. That's why demagnetized tools stay sharp longer.



The Ideal Demagnetizer has an indicating light which shows when current is on. Has all metal, streamlined case. Rating, 115 volt, 50-60 cycle (5 amp.) Other voltages and frequencies available. Size 5¼ x10½ x4½ inches. Weight 17 pounds.

Nepco Catalog and Data Book

The National Electric Products Corp., Pittsburgh, Pa., has just announced a 350-page engineering data book and catalog of National Electric Products. Attractively bound in a flexible blue cover stamped in gold, this comprehensive publication includes complete catalog specifications and prices on conduit, industrial busways, surface raceways, "Plug-In" strips, armored cable, flexible tubing, "Gorilla Grips," brackets and wireholders, fuses and wire and cable.

The engineering data section contains tables, wiring data, commonly used formulas, voltage drop curves, and similar data that will be helpful to anyone concerned with wiring problems. A special feature of the publication is a listing of the Federal specifications with which the National Electric Products comply.

Industrial Wiring Practice—Part 3

(Continued from page 42)

may be so great that a much larger size of conductor will have to be extended for the load. An economic study of the set up may show a decided advantage for some raceway system and a resultant closer spacing of conductors. The use of bus ways, especially the newer types designed for low voltage drop, are decidedly desirable and quite often prove to be the most economical system to install when the entire problem of feeder sizes, voltage drops, etc., has been worked out for any one system.

With the reactance of the service, the feeder, or the branch circuit system determined, the problem then is to calculate the actual voltage drop in the system. For the 4/0, two-wire, single-phase feeder spaced on 4-inch centers, the reactance is .376 ohms per mile (.071 ohms per 1000 feet) per conductor, and the resistance is .275 ohms per mile (.052 ohms per 1000 feet) per conductor. The full load current capacity as shown by Table 2 of the Code for 4/0, Type RH, conductors installed on insulators is 385 amperes. The resistance drop for full load will be: 358 amperes x .052 ohms/thousand feet = 18.6 volts/thousand feet. If a hundred foot circuit is used the actual drop will be 20% of this value (100/1000 x 2 wire for the circuit) or 3.72 volts drop due to resistance.

The reactance drop for full load on the same basis will be: 358 x .071 ohms x .2 = 5.08 volts.

The total voltage drop for the single phase circuit is not equal to the arithmetical sum of the resistance and reactance drops. The actual total circuit drop, or as it is usually called, impedance drop, is found by the following formula:

$$\text{Impedance drop} = \sqrt{(IR)^2 + (IX)^2}$$
$$= \sqrt{3.72^2 + 5.08^2}$$
$$= \sqrt{13.84 + 25.80}$$
$$= \sqrt{39.64}$$
$$= 6.29 \text{ volts}$$

The arithmetical sum would give 8.8 volts drops.

Figure 5 shows the simple vector diagram for the results calculated above. It should be noted that while the diagram shows the vector relations for full load conditions, the angular relations for the particular system will not change. In other words for any one circuit or feeder the wiring itself has a "power factor" which is independent of loading and operation of the wiring system provided of course the frequency of the system is kept constant. The power factor is obtained from the ratio of the resistance to the impedance and is expressed as a percentage. Thus for the above 4/0, 2-wire, single-phase circuit, the wiring power factor will be 3.72/6.28 x 100% = 59.14%.

Referring to a standard table of trigonometric functions it will be observed that the angle at "A," the power factor angle, is squal to 53° 44′ 34″, i.e. the cosine of 53° 44′ 34″ is equal to .59141.

If the vector diagram is laid out to scale, as in Figure 5, all the calculations may be checked graphically and for all practical purposes will give results which are very accurate and correct. In Figure 5, line "AB" is laid out to a convenient scale to be proportional to the resistance drop, IR, and "BC" is proportioned to the reactance drop, IX. Measuring line AC, it will be found that to the same scale it is 6.29. Measuring the angle at A with a protractor it is found to be about 54°. The cosine (or power factor) for this is .58779 or an error of 362 parts

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. . . . . AND MEET EVERY REQUIREMENT
MOST MODERNLY, COMPLETELY, DEPENDABLY

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Insure greater safety in wiring and the elimination of all grounding hazards. Made of the best quality of white porcelain. Metal inserts are placed in two holes of the switch boxes for receiving screws of standard switches, plug outlets, etc. Knockouts for single wires, also for cables. Specify and use them.

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Cement coated — extra length nail — genuine leather washer — code standard. They don't chip when driven in and they do stay in place and have a firm grip. Available in a wide variety of heights, diameters, holes, and grooves.

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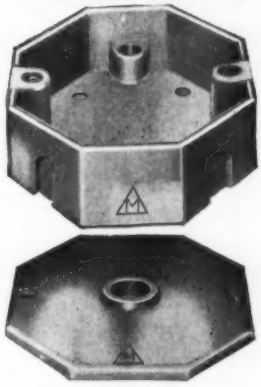

Glazed and unglazed styles conforming to all existing standards of dimensions, spacing, position of knockout holes, and mounting screws. High mechanical and electrical efficiency.

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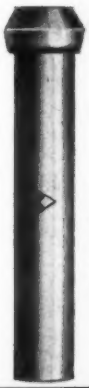

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in 10000 (or .06% error) which certainly can be neglected for all practical evaluations.

While the actual drops were used to obtain the diagram, the same results could have been determined from the plotting of the actual resistance and reactance values to a suitable scale. Again, it should be emphasized that these relationships are always constant for any one wiring system and are independent of the loading of the circuit for any one constant frequency.

Infra-Red Lamp—New Industrial Tool

(Continued from page 40)

amel and are completely dry in 18 minutes. 1,990 reflectors, housing various wattage lamps and pulling a total of 303 kilowatts, make this one of the largest installations in use today.

Advantages of radiant energy are found not only in the large jobs where paint-baking is the dominant application. Dehydration and drying are also important activities. Electrical contractors and electric motor men have found the process not only advantageous, but in many cases a necessity in repairing large motors, stators and rotors that would result in too excessive costs if other methods were employed.

Quality Electric Co., in Los Angeles, Calif., was required to dry out and bake the insulation on a 2500-hp, 360-rpm, 2300-volt slip ring motor, used to drive the main pump on the dredge "Hindes", owned by the San Francisco Bridge Company. To remove this huge motor would have been difficult and expensive. Time was short because the dredge was scheduled to sail for Honolulu to begin an extensive dredging contract for the government. Sixteen reflectors using 250-watt lamps were mounted on strips and rotated on the inside of this motor to dry out the moisture and bake the insulation.

This same company also reports their ability to dry out and bake the insulation on a 550-hp, 150-rpm motor in a total of 44 hours. 36 hours were required to dry it out, and only 8 hours for the baking of the finish.

Bearden & Thompson, electric motor repair shop at Atlanta, Ga., uses radiant energy to bake the insulation on motor windings.

How War Needs Affect More Than A Million Families Who Have Bought Hotpoint Electric Ranges

WINNING THE WAR is the first job of every American. And that means going without some of the things we've all taken for granted. The engineers and production experts who made more than 1,000,000 Hotpoint Electric Ranges are busy supplying Hotpoint equipment to hundreds of Army and Navy posts, as well as to cafeterias in war industry plants. While the war lasts, only a limited number of new electric ranges will be available for home use, thus releasing tons of vitally needed materials for war production.

TO EVERY family who has bought a Hotpoint Electric Range, we say—you have a durable cooking appliance. If yours is a modern Hotpoint with long-life Calrod cooking units, it should, with reasonable care, far outlast the "duration". Tests show that Calrod units are built with such durability they last for an average of fifteen years under normal kitchen use. If you *should* need replacements, they will be available.

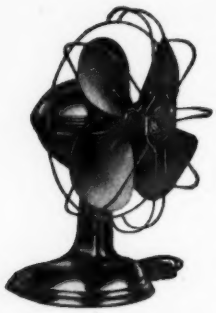
REMEMBER, too, that the proper care of your range will help you conserve food and preserve healthful minerals and vitamins. By correct use of Hotpoint's Measured Heat, you can get the most out of your range and cooperate with Uncle Sam's nutrition and conservation programs. Unnecessary use of high heat wastes current. Study the instructions that came with your range for further suggestions about conserving food and electricity. Or write us for a free, informative booklet on this subject. Hotpoint is always glad to help you in your all-out effort to keep the American family happy, healthy and well-fed. Edison General Electric Appliance Co., Inc., 5681 W. Taylor St., Chicago, Ill.

It's easy for users of all Hotpoint Electric Appliances to keep them in proper condition during the war emergency. Repair and replacement parts are available throughout the country if required.

Hotpoint

ELECTRIC RANGES, REFRIGERATORS, WATER HEATERS, WASHERS, IRONERS, DISHWASHERS, DISPOSALLS, ELECTRASINKS, STEEL KITCHEN CABINETS

THIS IS the first of a series of Hotpoint advertisements in Weekly magazines, Women's publications and Home periodicals. While this is addressed to more than a million users of Hotpoint Electric Ranges, it carries an important reminder to the millions of other families who will become buyers of Hotpoint Electric Appliances when they are again available. Edison General Electric Appliance Co., Inc., 5614 W. Taylor St., Chicago.



TAKE OUR WORD FOR THIS —ON R&M FANS!

Everyone predicts that there won't be enough quality fans to supply the demand this summer. But you can protect *your* interests—as others are—by ordering R & M fans *now!*

You see, even though we are "up to our necks" in war production, we're able—for the *present*, at least—to make shipments of fans to our distributors. We don't know how *long* we can continue making fans, or how *many* we can make. But we believe we'll be able to fill most of the orders that come in *soon*.

Your distributor, however, can't order *your* fans till you let him know *how many* you'll want. That's why we urge you to send him your order immediately—for delivery as soon as possible. Then when his order is filled—in whole or in part—we're sure he'll see that you get your share.

You have our word that the fans we *will* make will be as *fine as ever* in construction, performance, efficiency and durability. And considering higher production costs and higher taxes, they'll be better values than we've ever been able to offer in the past.

Get in touch with your R & M fan distributor *now*. If you don't know the name of the distributor nearest you, write us at the factory or ask the nearest R & M Branch Office listed below.

Retail prices — including Federal Excise Tax — of 1942 desk models (60 cycles, A. C.) are listed here for your convenience:

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10-inch, $12.35	12-inch, $30.60	12-inch, $34.35
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KANSAS CITY, 2105 Grand Ave. NEW ORLEANS, 500 Camp St. DALLAS, 1100 Cadiz St.
SAN FRANCISCO, 237 Rialto Building
THE ROBBINS & MYERS CO. OF CANADA, LTD., Brantford, Ont.

They estimate a saving of 50% in time by using this method. They report a 15-hp motor can be given 4 dippings of insulation and completely baked in 18 hours as compared with 48 hours previously.

To say that near-infra-red will fit every production demand would be overstating, although every day brings new applications and new successes. There are many cases where the process can be used supplementary, and definitely do a job that pays for the installation many times over in addition to "upping" production.

For instance, take the case of Downs Carpet Co., at Philadelphia, Pa. Although it is not a defense application, it serves to show a comparatively small installation solved a "bottleneck" in drying rugs and carpet.

At Downs the problem was to accelerate drying after the rugs and carpets were given a final steaming through the back to open up the pile tufts, closed or matted in previous operations.

All drying was being done by passing the rolls of carpet face-up over a large steam-heated drying drum. Production of the dryer was so slow that in order to keep up with weaving production, the steaming and drying unit quite frequently had to be operated until eleven or twelve o'clock at night.

Strips of near-infra-red lamps were installed as supplemental equipment in front of the drying drum and immediately a 25% speed-up on heavy goods, and as much as 30% to 35% increase on lighter materials, resulted.

Southern Spring Bed Company, at Atlanta, found that radiant energy would do in 45 seconds the same job for which other methods would require one hour, and the equipment to operate the conventional method would cost five times as much as infra-red equipment. They use the process to dry sprayed latex on auto seat material which holds the cotton batten in place during the manufacturing process.

Industrial Plants Need PF Correction

(Continued from page 34)

total time, while welds are actually being made.

It was stated that this plant has a flash welder, and an arc welder. If the flash welder duty

cycle is such as to be of interest in relation to plant power factor or steady state power factor, a shunt capacitor may be used with it. Usually, this load is lumped with the entire plant load. Where, for certain reasons, it is necessary to correct the power factor of the flash welder to relieve the load on a feeder supplying the welder, to reduce heating, or raise steady state voltage at the welder, a shunt capacitor can be used. A shunt capacitor, however, will not eliminate lamp flicker caused by the flash welder, neither can a series capacitor be used with a flash welder for this purpose for technical reasons too long to include in an article of this type.

Application of Series Capacitors

The flicker is actually the result of line drop resulting from line reactance. Even if the instantaneous kva drawn by the flash welder cannot be reduced by a series capacitor, the line reactance can be canceled by a series capacitor. Such a series capacitor must be placed in the main supply, and the value of capacitance can only be arrived at after a thorough study of the entire system from the substation bus out to the welder or device causing the flicker. Such series capacitors have been applied with very satisfactory results, but they are usually not practical unless they can be installed in the primary supply, because the secondary voltage is too low for a series capacitor of this type.

Where the plant layout and motor operating schedules are such that automatic control of kva cannot be secured by direct connection to motors, and where it is still necessary to vary the correction with load conditions, an automatic control can be applied. Assuming that the only reason for varying the correction is because of the effect the capacitor has on the voltage then the logical type of control is an electrically operated switch and voltage responsive control.

Assuming that the purpose of the automatic control is to vary the capacitor kva in such a way as to keep the power factor corrected within a predetermined range, then the capacitor bank should be controlled by means of an electrically operated switch and reactive kva relay.

In either the voltage or reactive

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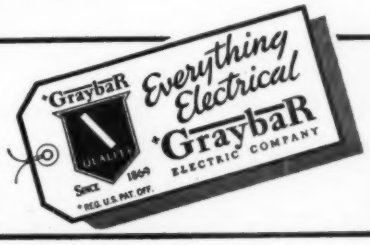

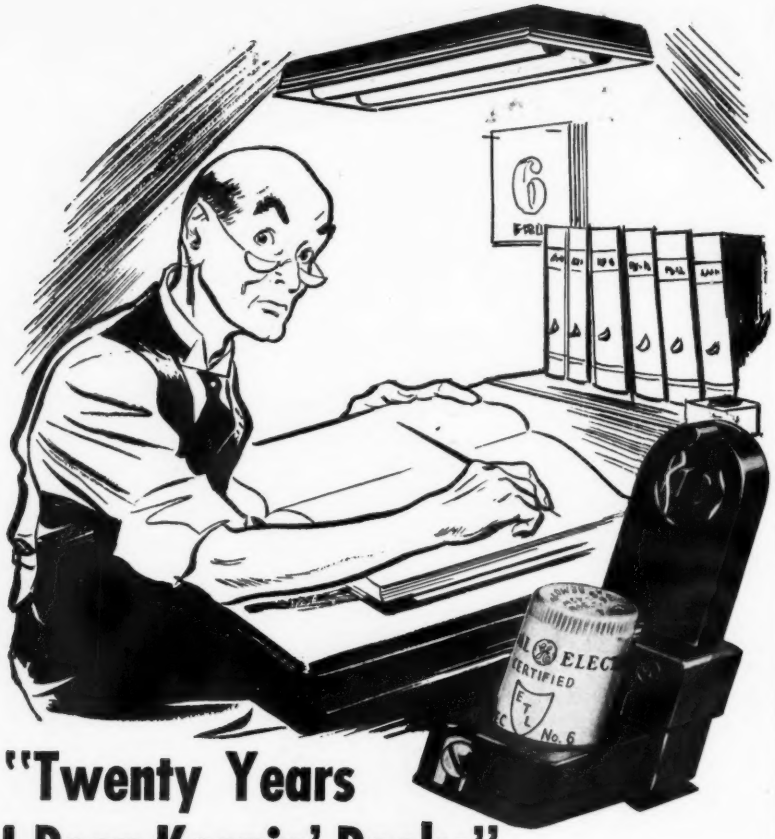

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G-E Rotating Lock Lampholders brought a substantial savings in maintenance costs because the superior design permits quick *one-hand* lamp insertion and removal.

And lamp investment — a big expenditure — is protected by the positive locking action of G-E Rotating Lock Lampholders because it grips the lamp firmly and safely.

Believe McGillicuddy . . . it pays to get the right Starters and Lampholders that give low maintenance costs, protection for lamp investment and long, dependable fluorescent lamp performance.

You can put new savings in your books by insisting on G-E Starters and Rotating Lock Lampholders for your fluorescent lighting equipment. Send now for this fact-packed folder. It tells about the importance of proper accessories . . . their functions . . . and the complete General Electric line. Write to Section G-2163, Appliance and Merchandise Department, Bridgeport, Connecticut.

GENERAL ELECTRIC

kva control, suitable accessory relays, etc., are necessary to avoid hunting or too frequent switching, and to avoid reclosure of the breaker after it has tripped on overload or due to a short circuit. Such controls are available as accessories to standard capacitor equipments.

Figure 7 illustrates an outdoor type capacitor with automatic voltage control single step type. This takes the capacitor off the line when the voltage exceeds a predetermined value and reconnects it when the voltage falls below a predetermined level.

With loads increasing as they are, there are many cases of overloaded circuits both on the power system and in plants, which can be relieved by means of capacitors with a large net gain. Analysis has shown that great overall savings result from using capacitor rather than add copper to circuits or take other steps necessary to handle these loads. Even on new installations it is cheaper to correct load power factor than to supply magnetizing kva from the central station because with rare exceptions it is not economical for the utility to supply magnetizing kva beyond a small proportion without crippling its service to all customers alike, and increasing capital costs due to larger and more costly equipment in proportions to useful power delivered.

Selection of Circuit Protective Equipment

(*Continued from page 29*)

are definitely under the heading of circuit protective equipment. These devices in common with certain practices, such as system grounding and breaker interlocking, can be justified as valuable system adjuncts on their own merits, with little or no effect that complicates the selection of other distribution system material.

In conclusion, emphasis is again placed on the important effect of the distribution system design on the cost and value of the circuit protective equipment, and on the more easily understood effect of an adequate circuit protective system on overall system characteristics. When distribution system design permits a practical and adequate protective system, the investment in modern circuit protective equipment can be expected to produce substantial returns.

A WAR MESSAGE
to
ALL EMPLOYERS

★ From the United States Treasury Department ★

WINNING THIS WAR is going to take the mightiest effort America has ever made—in men, in materials, and in money! Every dollar, every dime that is not urgently needed for the civilian necessities of food, clothing, and shelter, must, if we are to secure final Victory, be put into the war effort.

An important part of the billions required to produce the planes, tanks, ships, and guns our Army and Navy need must come from the sale of Defense Bonds. Only by regular, week by week, pay-day by pay-day investment of the American people can this be done.

This is the American way to win. This is the way to preserve our democratic way of life.

Facing these facts, your Government needs, urgently, your cooperation with your employees in *immediately* enrolling them in a

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The Pay-Roll Savings Plan is simple and efficient. It provides, simply, for regular purchases by your employees of United States Defense Bonds through systematic—yet voluntary—pay-roll allotments. All you do is hold the total funds collected from these pay-roll allotments in a separate account and deliver a Defense Bond to the employee each time his allotments accumulate to an amount sufficient to purchase a Bond.

The Pay-Roll Savings Plan has the approval of the American Federation of Labor, the Congress for Industrial Organization, and the Railroad Brotherhoods. It is now in effect in several thousand companies varying in number of employees from 3 to over 10,000.

In sending the coupon below, you are under no obligation, other than your own interest in the future of your country, to install the Plan after you have given it your consideration. You will receive—1, a booklet describing how the Plan works; 2, samples of free literature furnished to companies installing the Plan; 3, a sample employee Pay-Roll Savings authorization card; and 4, the name of your State Defense Bond administrator who can supply experienced aid in setting up the Plan.

To get full facts, send the coupon below —today! Or write, Treasury Department, Section B, 709 Twelfth St., NW., Washington, D. C.

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1. It provides immediate cash now to produce the finest, deadliest fighting equipment an Army and Navy ever needed to win.
2. It gives every American wage earner the opportunity for financial participation in National Defense.
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4. It reduces the percentage of Defense financing that must be placed with banks, thus putting our emergency financing on a sounder basis.
5. It builds a reserve buying power for the post-war purchase of civilian goods to keep our factories running after the war.
6. It helps your employees provide for their future.

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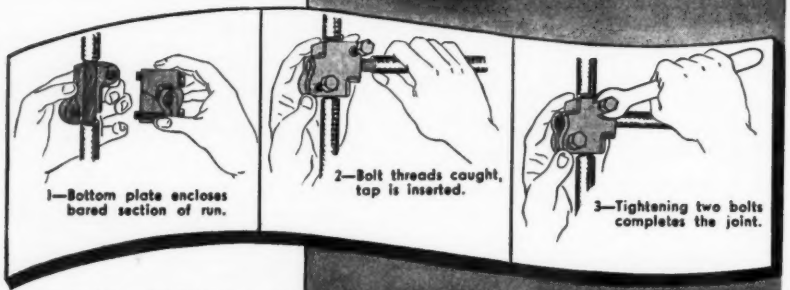

1—Bottom plate encloses bared section of run.

2—Bolt threads caught, tap is inserted.

3—Tightening two bolts completes the joint.

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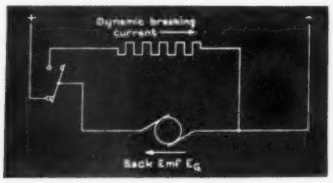
Selection of D-C Motor Control

(*Continued from page 25*)

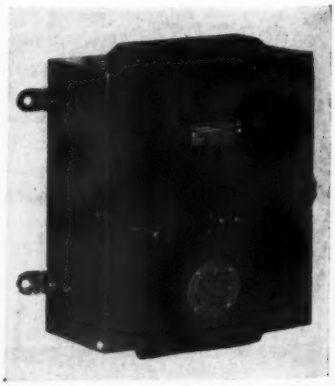
d-c motor will restart on full voltage with no starting resistance in the circuit, which endangers the motor windings and the driven machinery. These dangers are eliminated in most cases by undervoltage protection in the starters.

In the great majority of applications, a machine is stopped by simply disconnecting the motor from the line and allowing it to coast to a standstill. However, it is sometimes necessary to stop a motor quickly—as on a crane, a machine-tool drive, etc. In such instances, a mechanical brake can be applied to stop the motor and load quickly. However, motors can be stopped more economically in most cases—and wearing parts will be eliminated—by using the motor itself as a brake.

It has already been pointed out that a running d-c motor generates a voltage called *counter emf* opposing the applied voltage. On *shunt* and *compound* motors this



can be utilized in stopping. When the motor circuit is opened, a dynamic braking resistor is connected in parallel with the armature. The shunt field remains energized. The motor now acts as a generator, with the braking resistor as a



Manual resistance starter of commonly used type. Moving handle slowly upwards results in smooth acceleration.

+ + + + + + + + + + + + + + +

Why your Red Cross urgently needs

FIFTY MILLION DOLLARS, NOW

How the fund is allocated . . . What it does in service

Every dollar that you give now to your Red Cross marches into the thick of things where humanitarian help is needed most—up to the fronts and battle stations where the fighting is heaviest. Into the Red Cross hospitals and First Aid units where prompt medical attention and supplies may save innumerable lives. And throughout our broad land to train and equip volunteers to meet any emergency that may strike.

How the $50,000,000 War Fund is Used

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Provides for the care, welfare and morale of the Army and Navy, including services to men in hospitals and during convalescence. ● Provides an important link between the service men and their families; keeps the families from breaking up, supplies food, shelter, medicine, and even jobs where necessary. ● Provides essential medical and other supplies outside of standard Government equipment. ● Operates Red Cross headquarters at camps and naval stations. ● Enrolls blood donors and medical technologists for Army and Navy needs. ● Provides millions of surgical dressings, sweaters, socks, etc. through volunteer workers.

DISASTER AND CIVILIAN EMERGENCY RELIEF . . $10,000,000

Supplies emergency needs for food, clothing, shelter and medical attention for disaster victims. ● Assists stricken families in repair of homes and other adjustments; provides minimum reserves of essential relief supplies to prevent unnecessary delays.

CIVILIAN DEFENSE SERVICES . . . . . $ 5,000,000

Trains volunteers for home nursing and nurses' aides. ● Trains nurses, men and women, for active duty with the Army and Navy. ● Trains volunteers in First Aid and Accident prevention. ● Trains volunteers for work in Motor Corps, Canteen and Production. ● Instructs men, women and children in preparedness against explosive and incendiary bombs. ● Organizes for evacuation of children and their families from stricken areas. ● Assists Red Cross Chapters in establishing effective coordination of emergency relief with local and State defense authorities.

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Gives assistance and service to the 3,740 Red Cross Chapters with their 6,131 Branches responsible for local Red Cross activities, particularly welfare work among the service men and their families.

OTHER ACTIVITIES AND CONTINGENCIES . . . $ 6,000,000

Provides for unforeseen expansions in program and for new activities made necessary by unexpected developments.

TOTAL $50,000,000

THE AMERICAN RED CROSS $50,000,000 WAR FUND

Note to Red Cross Canvassers: Use this material to better inform contributors how their donations are being expended.

(This space has been donated free by this publication)

load, and quickly comes to a stop.

This is another quick-stop scheme commonly used for *series-wound* motors. When the "Stop" button is pressed, the controller reverses the power connection of the armature. This brings the motor to rest quickly because of the tendency of the motor to run in the reverse direction. With this system of stopping, a special resistor is required in series with the motor, since the "back emf" and the reverse power applied are additive and would cause excessive current to flow unless it were limited.

On machine tools, printing presses, and many other types of motorized equipment, it is frequently desirable to have a control which permits the operator to inch, or jog, the machine by a momentary pressure on the push button. This feature is essential for threading or setting up such a machine as a printing press. Jogging can be provided in most d-c magnetic controls, and requires the use of a push-button station having a jog button.

Modern Light For Industry

(*Continued from page 20*)

fort to workmen at adjacent positions. Excessive brightness contrasts between the supplementary lighted area and the surroundings must also be avoided—experience shows that comfort usually will be obtained if the brightness contrasts within the normal field of view do not exceed a ten-to-one ratio.

In some cases, the most important factor in the supplementary lighting problem is that of selecting the appropriate quality of illumination. That is, diffusion, direction, etc., may often be equally as important as the footcandle level. Such situations call for careful study and intelligent selection of the supplementary lighting equipment. For example, studies by the Illuminating Engineering Society have pointed out that large-area low-brightness supplementary lighting equipment provide excellent visibility for the reading of micrometers, verniers, cross-feed dials, and other similar tasks of this nature. On the other hand, certain inspection problems might best be illuminated with concentrating types of supplementary equipment.

How to Get the Most from Your Present Lighting Dollar

To many plant operators, the methods of improving general lighting systems here discussed will seem of little present value because of the non-availability of certain lighting equipments needed in such modernization programs. But there are several ways in which industrial executives can utilize their present installations to best advantage and get the most for the lighting dollar.

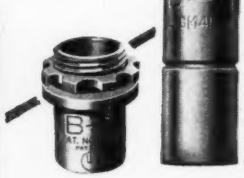
First of all, it will be encouraging to recall that the benefits of modern lighting for production result not only when an adequate level of illumination is provided but when the installation is as comfortable to the workmen as possible. For example, it has been proved by experience that production can be increased simply by eliminating direct glare. Certainly it will be worthwhile to carefully inspect present lighting facilities from the standpoints of all the lighting quality factors. Oftentimes the comfort of the illumination system can be improved without the use of critical materials but simply by the application of simple logic.

The second thing to do is to put the lighting system on a good maintenance schedule and see that luminaires are properly cleaned and serviced as planned. The maintenance problem is an important one for no matter how carefully a lighting system may be designed, the system must be kept clean if good lighting is to be maintained. This just involves promptly replacing burned-out lamps and cleaning lamps and reflectors at proper periodic intervals.

Workmen are rarely conscious of the gradual decrease in illumination because such decreases occur very slowly, due to (1) depreciation of the lamp light output during life, (2) the gradual accumulation of dust and dirt on lamps and reflecting surfaces, and (3) the very slow but continuous darkening of walls and ceilings. Good lighting installations have been known to actually depreciate to less than 50 per cent of their initial footcandle value before it

And there's just as much difference between the *streamlined* BRIEGEL METHOD of making connections and former old-fashioned methods.

The BRIEGEL METHOD saves you up to 50% on time and a substantial saving on materials allowing you a larger margin of profit on each job. Make quick, easy, strong and neat connections this MODERN way.



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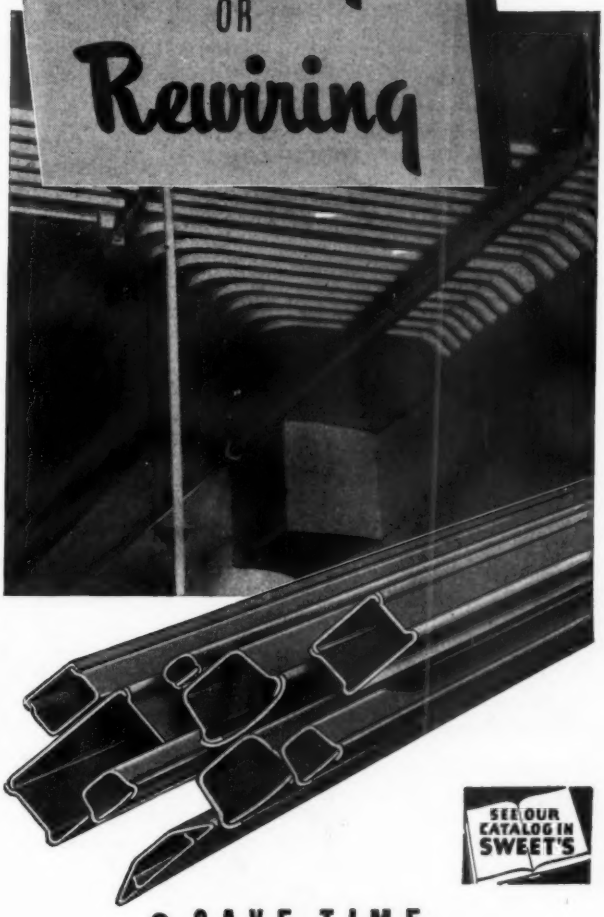

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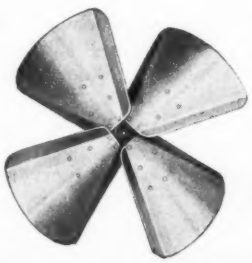

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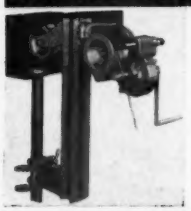

This handy Greenlee Cable Puller clamps right on to the conduit through which cable is pulled, is easily carried to the job, can be set up in a jiffy, and is easy for one man to operate with one or two cranks and will save many hours of work when pulling in cable.

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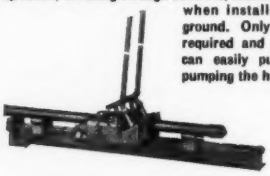

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was realized that a goodly portion of the lighting dollar was being wasted .

It is recommended, therefore, that a periodic illumination survey be made with a light meter, perhaps once a month. When the footcandle level drops to about 2/3 of its initial value (100-hour value in the case of fluorescent systems), the lighting installation should be cleaned. This procedure will determine the proper cleaning interval and will establish a schedule which can be followed in the future. Of course, frequent painting will also help maintain the lighting system at its optimum efficiency.

To many, the cleaning of industrial reflecting equipment simply means climbing up on a stepladder and wiping out the reflector with a damp cloth. Such cleaning methods should be discouraged for such procedures simply "push the dirt around from one corner to another." Employing a dry cloth is even worse for it not only fails to do an adequate cleaning job but actually damages the reflecting surface by forcing dirt and grime into it. The illumination can be improved 10 to 15 per cent after a dry-cloth wiping by *really washing* the lighting equipment instead of just swabbing it. The washing job can be done properly only when the reflector is taken to the floor.

Although fluorescent industrial luminaires present a somewhat greater area for washing than do filament-lamp reflectors, many manufacturers of industrial fluorescent equipment have simplified the maintenance problem by making their reflectors easily detachable so that they can be taken to the floor for washing without disturbing lampholders, starters, ballasts, wiring, etc. Disconnecting hangars are also available for lowering individual luminaires or sections of a continuous-row installation for convenient maintenance from the floor.

Modernized Wiring Essential to Industry

(Continued from page 15)

impedance designs for low power-factor loads. One advantage is that their large conductors provide good voltage regulation and thus allow for starting of heavy motors. Even the conduit extensions from these systems are being replaced by cables, a more rapid method which allows for some machine movement. Obviously, busways are not meant for installation in dirty or corrosive atmospheres.

When there is need for many connections, but where the flexibility of a busway system is not required, the wireway system of conductors is accessible square troughs makes an excellent and economical layout. Insulated gutter taps are recommended for the making of connections in wireways. These square ducts come in 2 1/2, 4 and 6 inches, and have continuous rows of knockouts. Recently, a large radio manufacturer used this method to supply taps to workbenches from an overhead system. Each 120-volt tap supplied a cutout box at the back of the bench.

The trolley duct system employing current collectors sliding in the duct eliminates long cords and is good for assembly work where the operations are carried on all along the line. It is a good system for stock bin lighting.

Modern wiring calls for dead-front, enclosed, trouble-free switchboards, except in large plants, where switchboard operators are always on duty. Slate or ebony-asbestos live-front boards are inexpensive, save on steel enclosures, and where properly applied, they give excellent service.

Modern practice is to build up a switchboard of metal-clad, factory-assembled units of standardized dimensions. These boards have good appearance, which always engenders neat maintenance. They come in both fusible-switch and air-breaker types. Air breakers are recommended, because they do away with the hazard and maintenance problems inherent with oil switches.

In modern panelboards, ease of maintenance and adequacy of interrupting capacity are featured in beaker units having removable mechanisms. These are well suited for motor work, and overcome the dangers of improper fusing.

The column type panelboards built to go between flanges of H beams are modern and carrying a full range of circuits at various system voltages.

Where circuits are to be added in old work, needed space can sometimes be gained by single-fusing old unidentified circuits.

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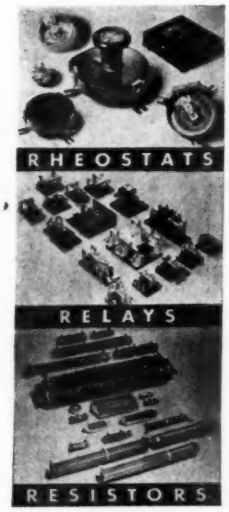

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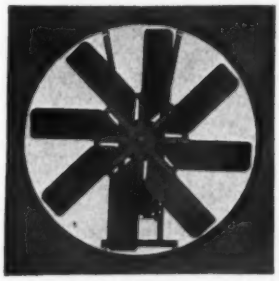

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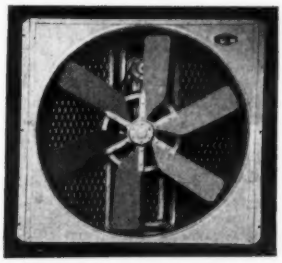

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Fusible switches should be selected on the basis of heat dissipation factors, which are ampleness of case and bigness of copper parts. When designing fusible switch applications, one would do well to keep in mind the inability of many fused switches to carry their full rated load continuously, because their ratings are based on tests without fuses in place. Some switches become comfortably warm when carrying one-half full rated load continuously. A desirable feature in modern switches are fuse clips having reinforced means of gripping the fuse terminals.

The further use of cords on machine tools recently brought in a proposal to require flexible cables without metallic covering; however, also provided that cable be of a type approved for the purpose.

Concerning transformers, there is a growing practice of using dry-type transformers either indoors or out to supply lighting and appliance loads from power feeders. It is sound practice where voltage regulation is satisfactory. Heavy busways are good for these combined

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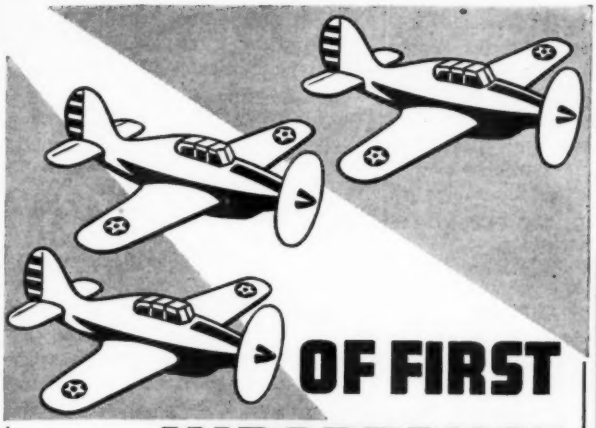

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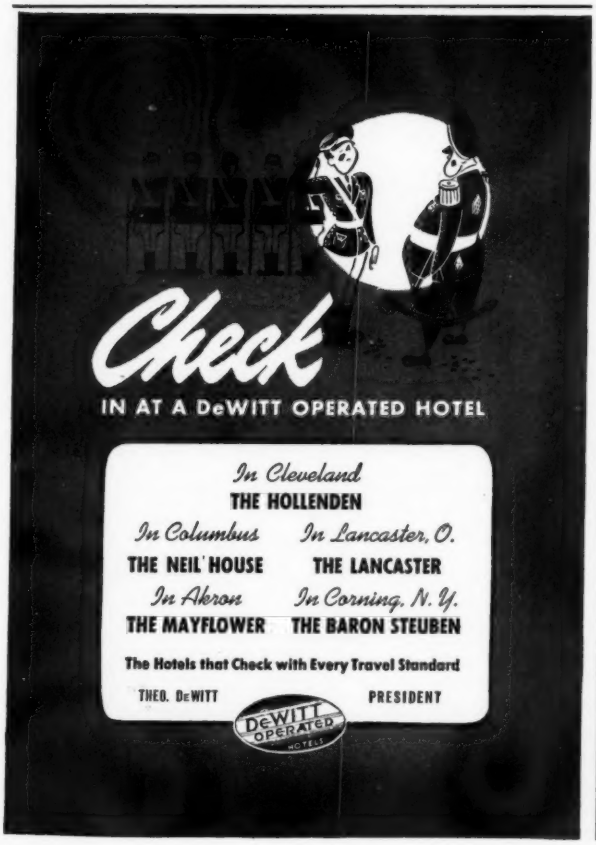

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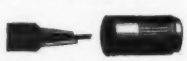

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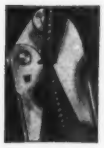

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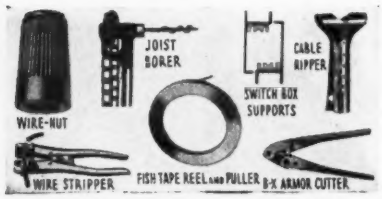

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power and lighting feeders.

Modern machine tools are coming equipped with their own small transformer to supply local lighting and appliances used at the machine.

For safety, low-voltage portable lamps are becoming available being incorporated into an assembly of lamp cord and dry-type transformer. Their low-voltage secondaries (not over 50 volts—National Electrical Code, Section 2545) remove the life hazard to workmen using appliances inside tanks and boilers.

Dry-type voltage regulators are modern equipment, available for manual or automatic operation. These find application at load centers.

A device coming into use for voltage correction is the series capacitor, which fits in well where there are fluctuating loads causing objectionable flicker. Best application seems to be where the heavy load is at the end of the line, because the sudden rise in voltage might be troublesome to lighting.

Shunt capacitors for improving power factor are available for such as wall mounting, and are being located at load centers.

Regarding voltage drop, in a recent case a small change overcame a difficulty. The brake coils of a 208-volt elevator would not release because starting voltage dropped to 195 volts. Running voltage of 205 was satisfactory. The solution was to install 200-volt brake coils, thus avoiding expensive rewiring.

A new sectional plastic surface wiring system has been introduced, designed for residential, commercial and industrial applications. It provides an outlet every eight inches of circuit run, and uses only two basic materials—copper and plastic.

Time-delay fuses have useful characteristics for the starting of heavy loads. They are not new, but by their use, one can often use a smaller cutout or fusible switch, or allow a fusible switch to carry a heavier starting load.

A modern practice is to use high-frequency systems for portable tools because their higher speeds (5400 rpm) give increased production. The 220-volt, 180-cycle power is supplied by a frequency-changer set operating from the 60-cycle circuit.

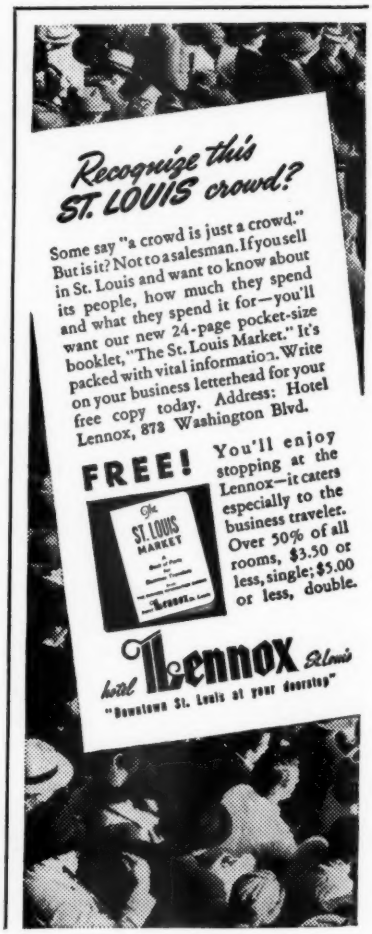
High frequencies are being applied to wiring systems to operate carrier current relays for the control of various operations as outside lighting and signalling.

Still higher frequency systems have to be maintained in industry's use of induction heating. Here voltage regulation is very important, because time of operation varies with voltage.

A word about a modern protective wiring method. This is a fence circuit installed in the posts which support a fence around a plant. If the barbed wire strands are mechanically displayed, say by a ladder being placed against them, the movement of the hinged arms causes a coded alarm to indicate that section of the fence over which an intruder is climbing.

Coming down to outlet boxes, we can save steel through the use of outlet boxes of insulating materials such as porcelain. Modern porcelain wiring systems have available a full line of cleats, tubes, boxes, covers and such.

At the final outlets, use modern factory-assemblies of ready-wired devices like switches plus pilot lights.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105. COOLAIR HOME-COOLING FANS—FORM 141—Complete descriptions of 1941 Coolair single and twin attic fans, window fan and new automatic ceiling shutter. Also contains valuable installation suggestions. Designated as Form 141. American Coolair Corp., Jacksonville, Fla.

113. INTERPRETING THE NEW CODE IN TERMS OF NEW BUILDING WIRES—A new booklet describing the rulings on thin, heat-resisting and synthetic insulations are carefully simplified. The ratings of the newly recognized types of wires and the new ratings for Type R are graphically shown in tables for both the new and rewiring classes of work. General Cable Corporation, 420 Lexington Avenue, New York, N. Y.

114. IDEAL PRODUCTS CATALOG — A special 25th anniversary catalog has just been issued describing the complete line of Ideal Products. Electrical Contractors, Motor Rewinders, and Industrial Maintenance Electricians will be particularly interested in this comprehensive publication. Ideal Commutator Dresser Co., 1270 Park Avenue, Sycamore, Ill.

115. FLUORESCENT LIGHTING ACCESSORIES—Fall Bulletin No. 3, describing and illustrating complete Lloyd line of Fluorescent Lamp Holders, Starters, Starter Sockets and Holder and Socket combinations. Lloyd Products Company, Providence, R. I.

117. MECHANICAL CONNECTORS—First Aid for electrical systems through the use of mechanical connectors is the subject of an interesting twenty-page booklet now available. In addition to specific construction and sales of the new "Gorilla Grip," this booklet describes a wide range of mechanical connectors for every size and purpose. National Electric Products Corp., Pittsburgh, Pa.

120. SQUARE D COMPANY announces the Spring issue of the Square D Digest, dated April, 1941. This condensed catalog contains listings and the latest prices of many Square D products, including Safety Switches, Service Equipment, Multi-breakers and other Circuit Breakers, Panelboards, Motor Control and Pressure Switches. Square D Co., Detroit, Michigan.

129. BULLETIN 403 on BullDog enclosed bus bar system of electrical distribution for commercial and industrial use. Forty-four pages of construction details, applications, dimensional data and technical charts. BullDog Electric Products Co., 7610 Jos. Campau, Ave., Detroit, Mich.

132. INDUSTRIAL WIRING HANDBOOK: This 48-page handbook, called "Adequate Wiring for Industry," describes modern factory wiring methods and materials. Wiring practices adaptable to all factories are outlined. Publ. No. 51-4011. General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.

142. ELECTRICAL CONDUIT: Complete technical information on corrosion-resisting asbestos-cement ducts for underground and overhead service, with and without concrete envelop, is included in "Transite Conduit and Korduct for the Electrical Industry," DS Series 410. Johns-Manville, 22 East 40th Street, New York, N. Y.

148. LITTLE GIANT RELAY—A new small Relay for use on A. C. or D. C. is described in a Ward Leonard Bulletin No. 105. The Relay is available in single pole, single or double throw contacts. On standard frequencies, coils can be obtained for 6 to 230 volts. Complete information on contact rating is given in the bulletin. Ward Leonard Electric Co., Mount Vernon, N. Y.

149. ELECTRIC RANGE UNITS: Chromalox Bulletin CF-107 lists proper assembly and adaptor ring to fit any range, regardless of age or make. Inventory investment and servicing reduced to minimum. Units same as used on many makes of new ranges. Edwin L. Wiegand Company, 7600 Thomas Boulevard, Pittsburgh, Pa.

155. ELECTRICAL CONNECTORS — 325 page catalog describing and illustrating Burndy clamp connectors for overhead distribution and transmission, substations, grounding, underground distribution and industrial wiring. Contains 84 pages of useful technical information. Company asks that requests for the catalog, Catalog No. 40, be written on company letterhead. Burndy Engineering Co., Inc., 107 Eastern Blvd., New York City.

156. INTERVAL AND PROCESS TIMERS—Furnished for any cycle of time, fully adjustable, for any purpose, any requirement, or any specified action. Each one built to meet individual specifications. Give information regarding what unit is to be used on, what it is to be used for, and what it is expected to do. Both Manual and Automatic Reset types available; individual or repeatingly continuous operation. Automatic Elec. Mfg. Co., Mankato, Minnesota.

157. PROGRAM OR SIGNAL TIMERS—Used extensively for starting and stopping working hours, marking the beginning and ending of school class periods, sounding municipal time signals, and so on. Write for descriptive circular. Automatic Elec. Mfg. Co., Mankato, Minnesota.

158. ELECTRIC MOTOR REBUILDING MATERIALS CATALOG — 28 pages — gives complete descriptions, specifications and prices on all materials and replacement parts necessary for the electric motor rebuilding shop. Insulation & Wires, Inc., 2127 Pine St., St. Louis, Mo.

159. NEW COMPLETE FLUORESCENT CATALOG NO. 114—Lists in detail fixtures for every type of lighting application. New units abound in this book which is sure to be welcomed as the complete story on fluorescent by architects, contractors and jobbers alike. Day-Brite Lighting, Inc., St. Louis, Mo.

160. ELECTRICAL CONNECTORS — Complete up-to-date catalog of Handy Electrical Connectors and devices for repair, maintenance and new construction. Ask for publication Z-103. H. B. Sherman Mfg. Co., Battle Creek, Michigan.

161. RECTIFIED FLUORESCENT LAMPS AND LUMINAIRES—A recent booklet describing RF lighting especially designed for industrial lighting needs. Illumination layout data and illumination tables illustrate this booklet. Lamp Department, General Elec. Co., Nela Park, Cleveland, Ohio.

163. TIME CONTROL DEVICES — Engineering data on automatic reset timers and Time Delay Relays suitable to control hundreds of industrial operations. Numerous specific applications described. Paragon Elec Co., 409 S. Dearborn St., Chicago, Ill.

164. INSULATING VARNISHES AND COMPOUNDS—40-page catalog assists in selection of the right insulating varnish or compound to meet any specific requirement. Contains helpful temperature conversion and tank capacity tables. Lists and describes all standard grades of DOLPH air drying and baking insulating varnishes and compounds. John C. Dolph Company, 166 Emmett St., Newark, New Jersey.

165. TECHNICAL DATA ON J-M TRANSITE ASBESTOS-CEMENT ELECTRICAL DUCTS—including installation and special fitting data on J-M Transite Electrical Conduit and Korduct—a bound set of technical data sheets on the two asbestos-cement duct materials. Primarily prepared for designing engineer and installation supervisor, the 42-page book is chuck-full of practical information for anyone concerned with underground or overhead duct installations. Tables giving dimensions of ducts and fittings and numerous installation photographs are included. Copies of the book, Form DS Series 410, may be obtained upon request to Johns-Manville, 22 East 40th St., New York City.

166. ATTIC FAN MANUAL. New 6-page bulletin entitled, "Hy-Duty Ventilators for Every Use"—Form No. 347-A—specifications, data and information on the installation of Fresh Air Maker Ventilators. New 4-page folder entitled, "Your Patrons Like A Fresh-Crisp Atmosphere"—Form No. 402—descriptive of the Fresh Air Maker for commercial purposes. Schwitzer-Cummins Company, Heating Division, Indianapolis.

167. NATIONAL ELECTRIC ENGINEERING DATA BOOK—A 350-page engineering data book and catalog of National Electric Products is now available. In addition to the section containing tables and wiring data, this publication includes complete catalog specifications and prices on conduit, industrial busways, surface raceways, "Plug-In" strips, armored cable, flexible tubing, "Gorilla Grips," brackets and wireholders, fuses, and wire and cable. A special feature of the publication is a listing of the Federal specifications with which the National Electric Products comply. National Electric Products Corp., Pittsburgh, Pa.

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Electrical Modernization For Industry

(Continued from page 11)

can not reasonably convert their plants to do so. What should be their attitude toward electrical modernization today? The management of these industries are just as patriotic, their plants are just as essential to the normal life of the nation as other plants. What should these indutries do when and if they desire to modernize during the present emergency?

It would seem that they could best serve their nation today by continuing to operate in such a way that they will place the least strain on the nation's resources of manhours or material. They should make a special effort to repair old equipment, and avoid all waste so as to save in every way possbile, from paper clips on the president's desk to baling metal normally thrown away in the receiving room. All industrialists falling in this category will, of course, familiarize themselves with the federal laws restricting the purchase of materials ad equipment and avoid conflicting with them. To do otherwise would be virtually sabotaging the Victory Program which no patriotic American would tolerate.

Those industries that fall into the second class, having exhausted all the possibilities of handling defense business on either a primary contract basis or on the basis of subcontracts, must closely analyze every phase of their respective enterprises. It is suggested that they intensify their policy of maintaining existing equipment by establishing definite lines of responsibility for this important work. Inspection schedules should be established incorporating a check list to see that nothing is overlooked. All old material and equipment should be salvaged to be used again for production or repairs. This is a time for the greatest thrift and economy of manhours, money, and materials.

Such industries should make a special effort to establish reserves and plans for modernization in the post-war period. After the war, material, equipment, and labor will likely be more plentiful and can be had at a much lower cost. This procedure, if generally followed, will provide a good backlog to business and help keep plants running and labor employed during the period of switchover from a war economy to a peace economy in this country.

It will be well to consider investing modernization reserves in defense bonds. Such a policy would be helpful to all parties concerned in that the nation would receive the loan so vitally needed, the industry will have a safe investment with a satisfactory return, money will have been taken out of the normal channels which tends to reduce the dreaded inflation, and after the war the ready cash will be available to make the moderization that will be needed at that time.

Now to summarize electrical modernization in industry today, it can be said that those who fall in the first class should do all in their power, at the prevailing cost, to modernize every item of their plants that will enable them to speed up production and at the same time make a better defense product, with the most efficient utilization of manhours.

Those who fall into the second class and who have been unable to contract for, or adapt their plants to, defense production, should do all in their power, through ingenuity and resourcefulness to make every edge count to the end that the least strain will be placed on the Victory Program already staggering in size. Generally speaking, these plants will put off until tomorrow every purchase of critical materials and equipment that they can do without today.

Those who come in between these two extremes should make only those necessray modernization steps that are consistent with the proportion of their output that fits in with the Victory Program, or will enable them to take on defense contracts.

Out of the dangers that lie ahead will emerge Southern industries which will have taken fullest advantage of the opportunities in the present crisis. The South will then be ready to meet the great reconstruction program that will develop in the readjustment period that will surely follow this present holocaust of confusion.

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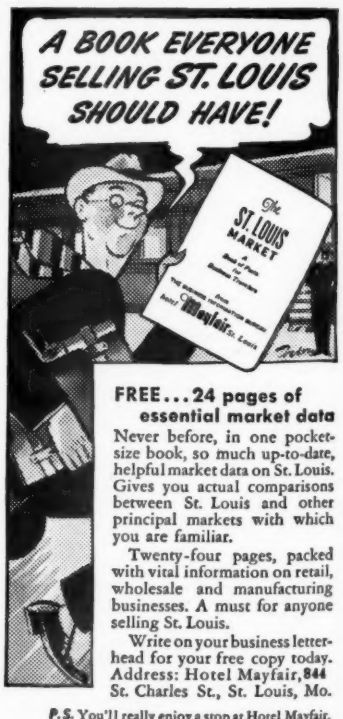
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March, 1942

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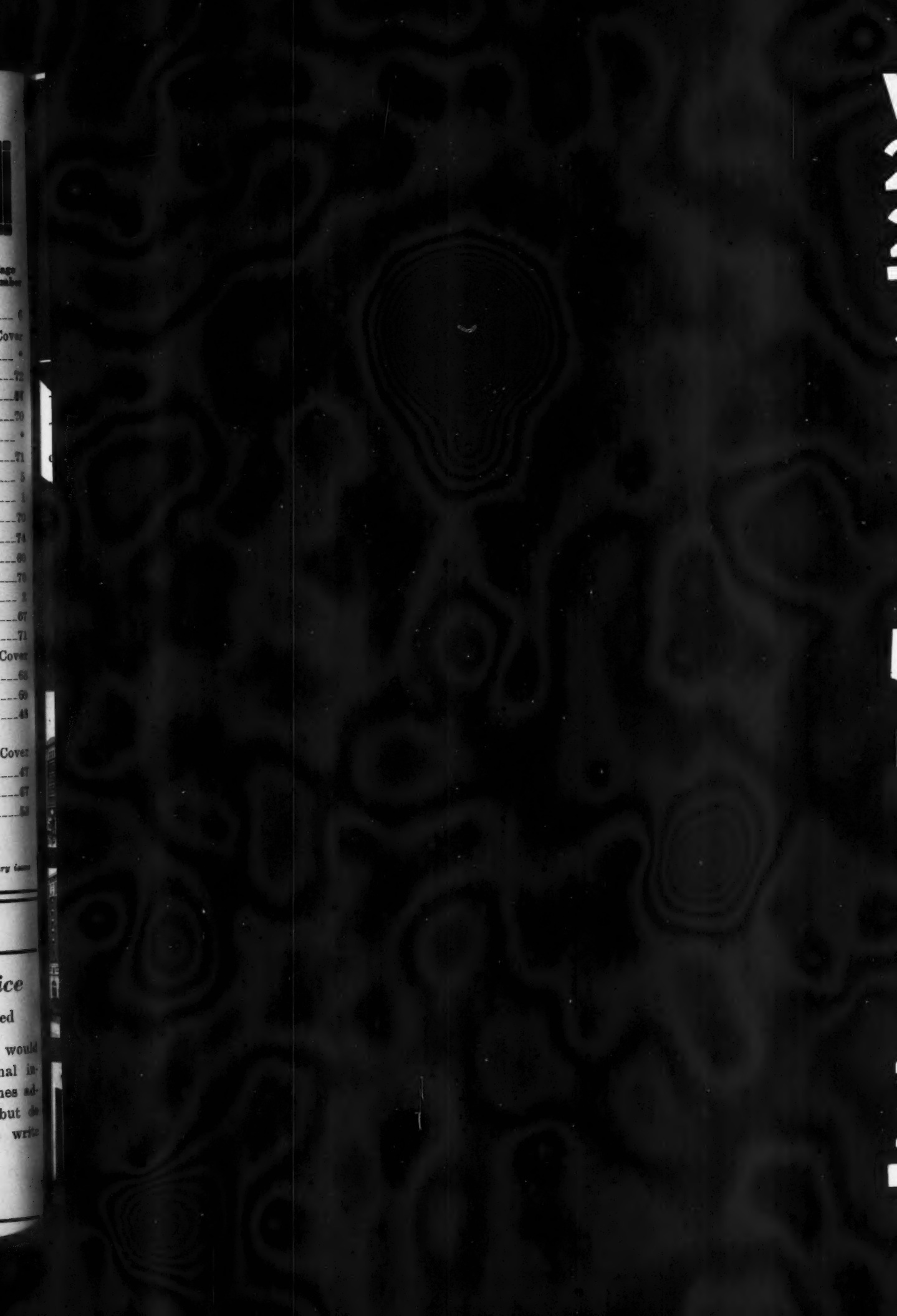
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